2326.

THE

ANATOMY

OF THE

HUMAN BODY.

VOL. III.

CONTAINING

THE ANATOMY

OF

THE ORGANS OF THE SENSES,

THE VISCERA OF THE ABDOMEN,

AND

THE MALE AND FEMALE PARTS OF GENERATION.

By CHARLES BELL, SURGEON.

2326

THE

ANATOMY

OF THE

HUMAN BODY.

CONTAINING

THE ANATOMY

OF

THE BONES, MUSCLES, JOINTS, HEART, AND ARTERIES,

By JOHN BELL, SURGEON;

AND THAT OF

THE BRAIN AND NERVES, THE ORGANS OF THE SENSES, AND THE VISCERA,

By CHARLES BELL, SURGEON;

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1811.

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EXPLANATION

OF

THE PLATES.

PLATE I.

THIS plate repreſents an ideal ſection of the abdomen, and the cut edge of the peritoneum is repreſented by the white line.

A. The LIVER.

B. The INTESTINES.

C. The KIDNEY.

D. The BLADDER of URINE.

E. The RECTUM.

1. The PERITONEUM, where it lines the abdominal muſcles.
2. The PERITONEUM, where it is reflected to form the ligament of the liver.
3. The liver being repreſented cut through, we can trace the lamina of the ligament 2, over its ſurface 3, forming the peritoneal coat of this viſcus.
4. Marks the PERITONEUM reflected from the liver upon the diaphragm.
5. Here the PERITONEUM is reflected off from the ſpine, to form one of the lamina of the meſentery.

6. The

6. The peritoneal coat of the inteſtine, which we can trace round the circle of the gut until it unites again with the meſentery.

7. 7. The PERITONEUM, forming the lower lamina of the meſentery.

8. The PERITONEUM at that part where it is reflected, and covers the kidney.

9. The PERITONEUM is here deſcending upon the rectum E, we ſee it reflected over the gut, and deſcending again betwixt the rectum and bladder.

10. The PERITONEUM where it forms a coat to the fundus of the bladder.

11. At this part we ſee the peritoneum reflected up upon the os pubis, and from that we trace it to fig. 1. Thus we ſee, that the peritoneum can be traced round all its various inflections and proceſſes; which ſhews, that it forms one continuous ſac, and that the inteſtines and the liver are equally on the outſide of this membrane with the kidney.

EXPLANATION OF PLATE II.

This Plate repreſents the epididimis and teſticle, injected with quickſilver, and diſſected.

A. The body of the teſticle with the tunica albuginea diſſected off.

B. B. The ſeminal veſſels in the body of the teſticle or TUBULI TESTIS *.

C. The RETE TESTIS formed by the union of the veſſels B. B.

D. The VASA EFFERENTIA, which as they proceed from the teſticle, are convoluted in a connical figure, and are called the VASCULAR CONES.

* Where the tubuli are emerging to form the rete vaſculoſum, or rete teſtis, they are called the *vaſa recta.*

E E. The

E E. The EPIDIDIMIS formed of the union of the vafcular cones; it is a little diffected and fpread out.

F. The vas deferens.

EXPLANATION OF PLATE III.

This Plate reprefents the proftate gland, veficulæ feminales, and lower part of the bladder, the parts being previoufly hardened in fpirits, the veficulæ were afterwards cut open.

A A. The body of the PROSTATE GLAND; it is that lower part of the gland which can be felt through the rectum.

B. The proftate gland is here cut into and diffected, in following the ducts of the veficulæ.

C. The extremities of the ducts common to the veficulæ feminales and vafa deferentia.

D D. The cells of the veficulæ feminales, which are laid open by a fection.

E. The left VAS DEFERENS, which is alfo laid open to fhew the cellular ftructure which it affumes towards its termination.

F. The RIGHT VAS DEFERENS.

G G. The foramina, by which the vafa deferentia open into the common duct.

H. The lower and back part of the BLADDER.

I. The RIGHT URETER.

EXPLANATION OF PLATE IV.

This plate reprefents a fection of the neck of the bladder.

A. The lower part of the urinary bladder near the neck.

B. The opening of the right ureter, which is marked I. fig. iii.

C C. The fubftance of the proftate gland, which is cut through; its thicknefs, texture, and the manner in

in which its furrounds the beginning of the urethra, will be underftood from this plate.

D. The URETHRA laid open.

F. The VERUMONTANUM, or CAPUT GALINAGINIS.

G G. The points of feathers put into the openings of the veficulæ feminales and vafa deferentia.

N. B. Round thefe ducts, on the furface of the verumontanum, and in that part of the urethra which is furrounded by the proftate gland, innumerable mucous ducts may be obferved: into fome of thefe fmall briftles are introduced.

EXPLANATION OF PLATE V.

A view of the penis, veficulæ feminales, and proftate gland.

EXPLANATION OF PLATE VI.

FIG. 1.

An ovum in a very early ftage, reprefenting the fhaggy furface of the true chorion.

FIG. 2.

We may fee here the fœtus in a very early ftage contained in the tranfparent amnion, and, attached to the outfide of the amnion, the VESICULA UMBILICALIS.

N. B. Thefe are not reprefentations of the fame abortion.

Fig. 3.

Reprefents the ovum a little more advanced.

A. The CHORION.

B. The AMNION.

C. The FŒTUS hung by the UMBILICAL CORD.

EXPLANA-

Explanation of Plate VII.

This plate reprefents two views of a conception, we fhall fay about the end of the firft month, and here the decidua and the ovum have been thrown off together. This abortion was prepared fo as to refemble the beautiful engravings in Dr. Hunter's xxxiv table.

Fig. 1.

The deciduous efflorefcence formed by the womb is feen here intire, and feen as if moulded to the cavity of the womb: it is only neceffary to obferve that it hung inverted.

A. The lower part of the conception, which was near the neck of the womb, and which has fome coagula of blood attached to it.

B. B. Quills introduced within the decidua by an opening near the neck of the womb, and their points brought out at that part of the membrane which anfwers to the opening of the Fallopean tubes: there it is either entirely deficient, or it is fo thin that it has been torn at C. C.

Fig. 2.

Here the other fide of the conception is fhewn, and the ovum is feen to have adhered to the outer furface of the decidua.

AA. AA. The quills introduced into the cavity of the decidua.

B. The fhaggy furface of the decidua.

C. C. The fleecy outer furface of the chorion.

It is here to be obferved that the ovum, C D E. may be fuppofed to be as it has defcended from the ovarium, only fomewhat enlarged, and it is here evidently on the outfide of the decidua, but it has been torn open, and that deciduous furface which connected it to the furface of the womb at this place has been left with the womb, to be afterwards thrown off with the difcharges.

D. The delicate membrane the amnios.

E. The umbilical cord, and part of the fœtus.

EXPLANATION OF PLATE VIII.

This and the following plate reprefents a conception of the third month, and as the abortion was thrown off very intire, we have another opportunity of obferving the ftate of the decidua in a more advanced ftate.

A. A thread paffed through the more folid placentary mafs fufpending the whole.

B. B. The DECIDUA, having a peculiar reticulated appearance.

C. C. Shreads of the DECIDUA, where it has burft in the delivery.

D. The DECIDUA REFLEXA, through which alfo the proper membranes have burft.

E. The TRUE CHORION.

F. Very fmall curling arteries which are entering the decidua, or what may be confidered as the maternal portion of the placenta.

EXPLANATION OF PLATE IX.

We have here prefented a view of a fection of the fame conception.

A. The DECIDUA.

B. B. The cut edge of the DECIDUA, which will be feen to furround the whole ovum, and particularly it may be obferved to form on the upper part a diftinct lamina from the placenta F.

C. C. The DECIDUA.

D. The DECIDUA REFLEXA.

F. The PLACENTA already formed by the accumulated veffels of the chorion.

G. The CHORION towards the lower part of the womb; here, it may be obferved the fleecy veffels have difappeared.

H. The AMNION.

I. The umbilical cord twifted three times around the neck of the fœtus.

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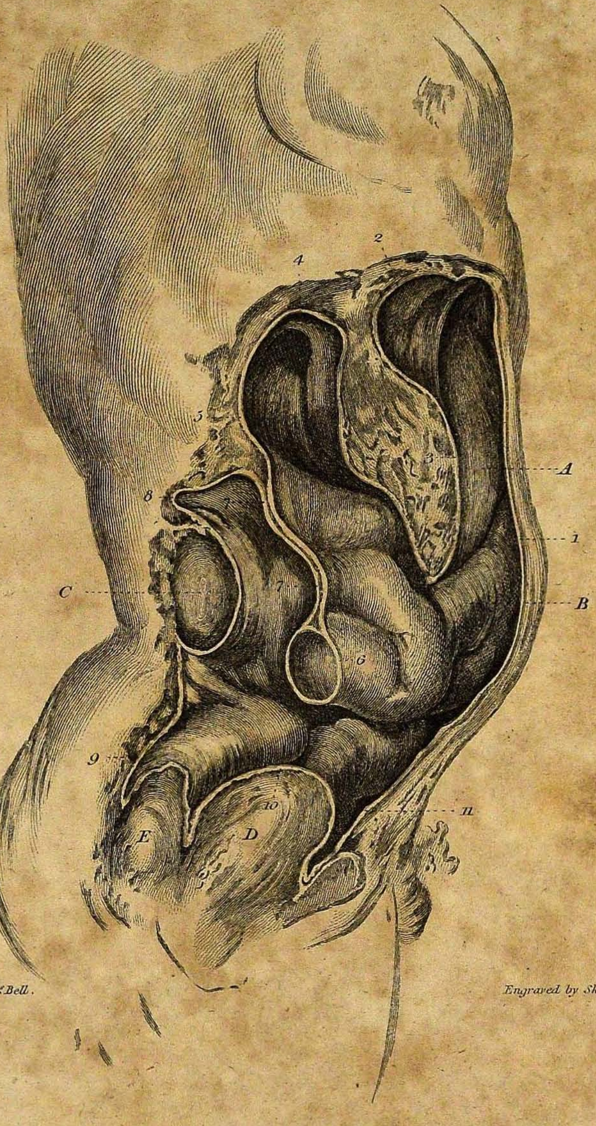
THE

Plan Drawing of the Abdomen, Showing the Inflections of the Peritoneum.



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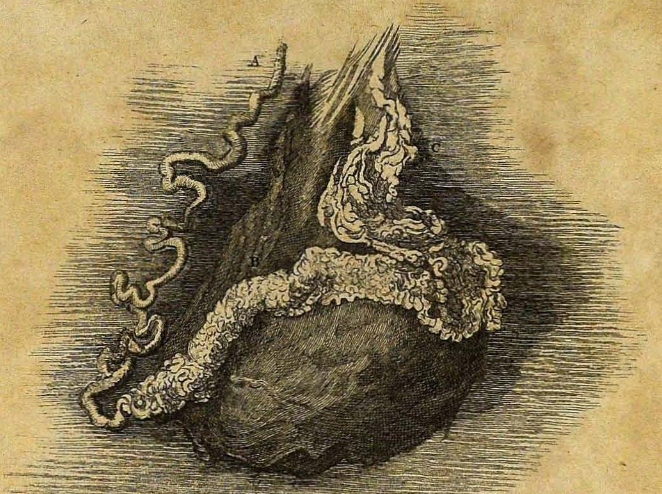

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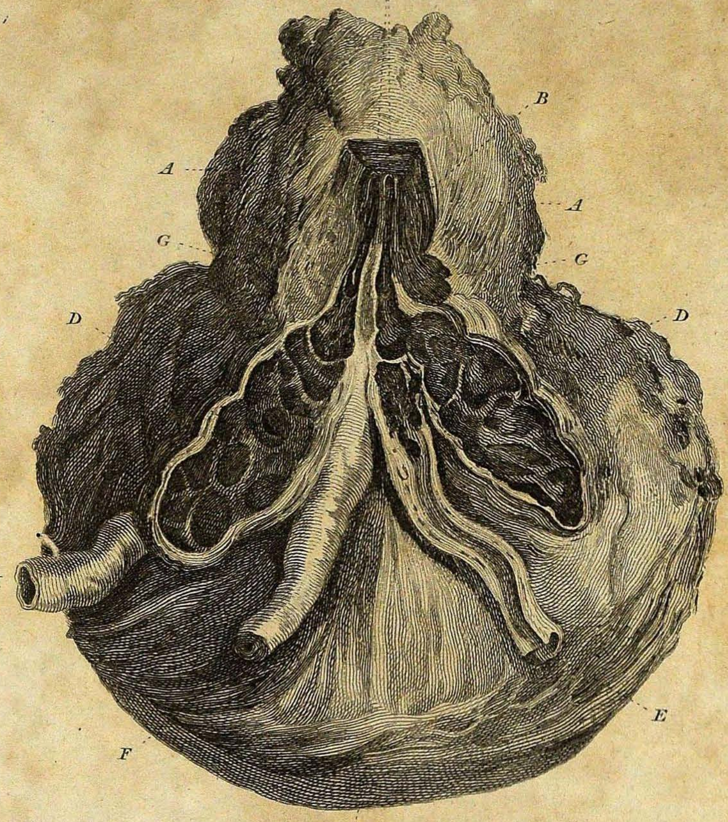

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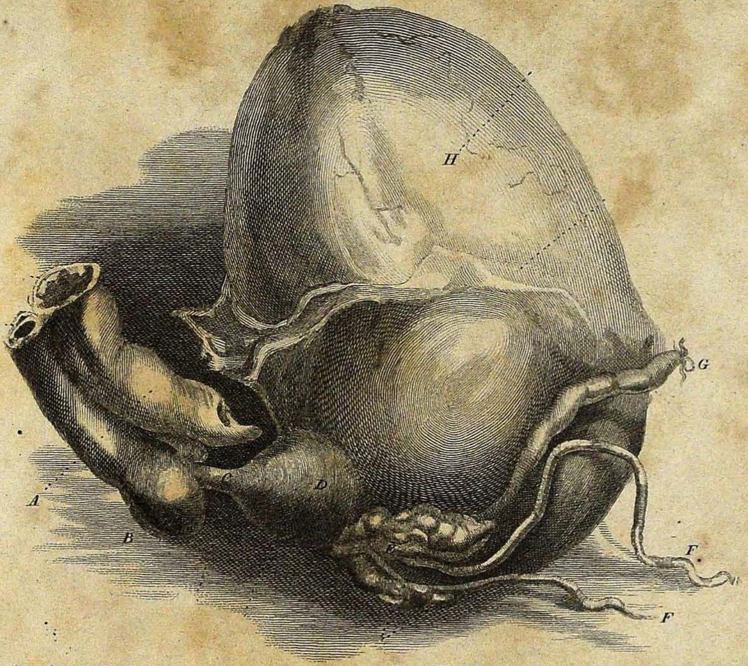

A. Crus penis.
B. Bulb of the Urethra.
C. Membranous p.t of the Urethra.
D. Prostate Gland.
E. Vesiculæ Semin.
F.F. Vasa deferentia.
G. The Ureter.
H. Bladder covered by the Peritoneum.

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Fig. 1.

Fig. 2.

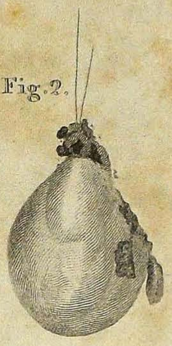

Fig. 3.

Chas. Bell delt. D. Lizars sc.

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Plate VII

Fig. 1.

Fig. 2.

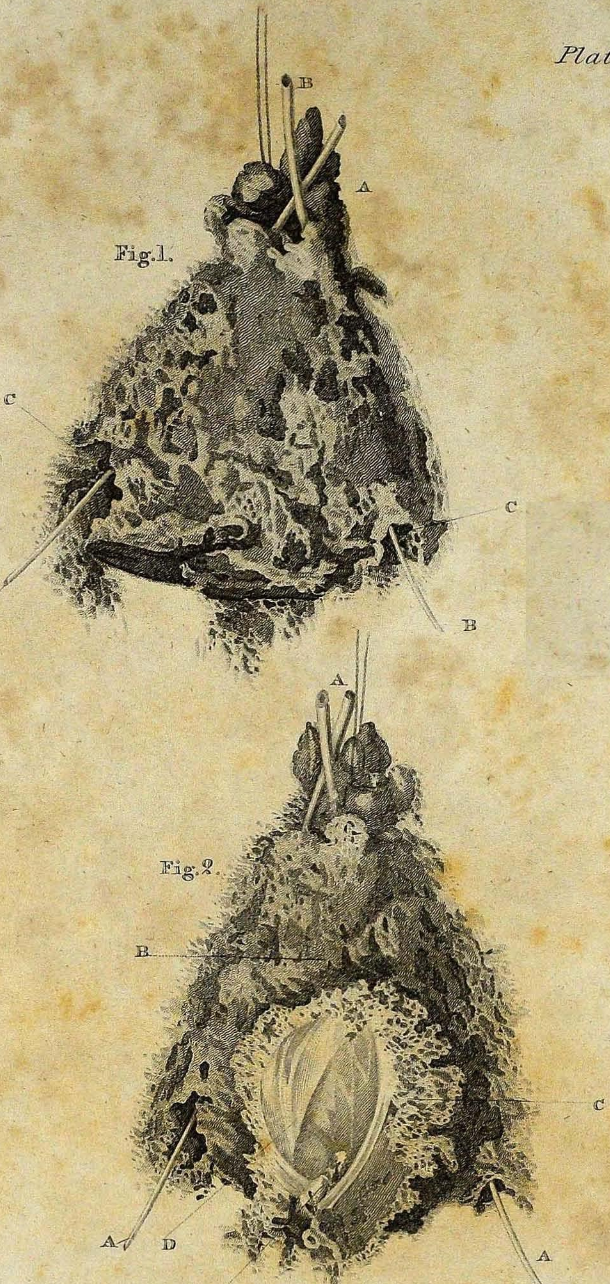

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Plate VIII.

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Plate I

Cha.s Bell del.t

D. Lizars sc.

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THE

ANATOMY

OF THE

NERVOUS SYSTEM,

CONTINUED.

OF THE SENSES.

INTRODUCTION.

The Senſes are thoſe faculties by which the active principle within us has communication with the material objects by which we are ſurrounded. Through them we receive thoſe ſimple ſenſations which are the firſt elements of our thoughts, and the means of developing all the powers of the underſtanding. The exerciſe of our ſenſes, however, is familiar to us from ſo early a period, that we never think of attending to their firſt ſimple intimations: before we are capable of reflecting on the nature of the perceptions which the ſeveral ſenſes convey, they are ſo complicated and diſtorted by habits and aſſociation, that obſervation comes too late for us to aſcertain the ſimple progreſs of nature. Philoſophy revives the natural feelings of wonder at the ſpectacle of the univerſe; but too often we follow the dictates of a creative imagination, and run into error and deluſion in ſtudying the operations of nature.

To one who looks upon nature with the calm and chaſtened delight which is the character of true philoſophy, there is a conviction that ſuch reſearches may

be carried too far. Wherever he directs his attention, whether to the ftructure of the human body, the phyfiology of vegetables, or the phænomena of chemical fcience; whether he endeavours to comprehend the fyftem of the univerfe, or pores over the minutiæ of natural hiftory, he finds every where a limit placed to his enquiries; a line which no induftry or ingenuity can enable him to pafs. We may pleafe ourfelves with conjecture beyond this limit, but we find that all our opinions on thefe fubjects are merely a dream of fomething allied to the impreffions of our grofs fenfes. The agency of the fenfes, the intercourfe betwixt mind and matter, and the influence of the will over the body, are myfterious, and, probably, inexplicable phænomena; yet we fcruple not to explain them precifely and mechanically; we reduce them to the level of our own capacity in the fame manner as we fabricate to ourfelves the idea of a deity by the combination of all human perfections. When we imagine that we have difcovered the fecret of thefe myfteries, it is mortifying to find ourfelves without any fign or language by which to communicate thofe great truths to the companions of our ftudies: we ftruggle for expreffion; and, as all our ideas upon fuch abftract fubjects are derived from analogy, we exprefs our opinions refpecting the powers of the mind, or the manner in which we perceive the objects of the fenfes, in the fame language, and by reference to the fame notions, which belong to the fenfations themfelves. From this fcantinefs and inaccuracy of language, it unavoidably happens, that very different ideas of the operation of the fenfes are expreffed by feveral men in the fame terms; and in attempting to convey our ideas in language more precife and definite, we are infenfibly led to materialize the faculties of the mind, and to make the operations of the fenfes merely mechanical. What other explanation can we give of theories, which fuppofe the nerves to be tubes carrying animal fpirits, or containing an elaftic ether; or which reprefent them as vibrating cords, and reduce all the variety of fenfation to the difference of tenfion and tone? Thefe are, indeed,

what

what Dr. Reid calls them, " unhandy engines for carrying images."

Nothing has been undertaken in philofophy but entire fyftems, fathoming at once the greateft depths of nature. The cuftom has been to frame hardy conjectures; and if upon comparing them with things there appeared fome agreement, however remote, to hold that as fully fufficient. What chimeras and monftrous opinions this method of philofophifing has brought forth, it would be more invidious than difficult to fpecify.

Bacon and Newton laid down the principles of philofophifing on this bafis, that on no account are conjectures to be indulged concerning the powers and laws of nature, but we are to make it our endeavour, with all diligence, to fearch out by experiment the real and true laws by which the conftitution of things is regulated. In the fubject now before us we have a very remarkable proof of the fuperiority of inveftigation by experiment over the lazy indulgence of conjecture; and I hope the whole tenor of the following account of the fenfes will ftrengthen the conviction of the ftudent, that it is only by affiduous ftudy, and patient obfervation of nature, that he is to look for the attainment of knowledge in the medical profeffion.

The office of the brain and nerves is to receive the impreffions of external bodies, by which correfponding changes and reprefentations are made in the mind. We know nothing further than that, by the operation of the fenfes, new thoughts are excited in the mind. Betwixt the fenfation excited in the organ of the external fenfe, and the idea excited in the brain, there is an indiffoluble, though inexplicable, connection; the brain is not fenfible, nor does the eye perceive, but both together give us the knowledge of outward things. But when the fenfation is once received and communicated to the brain it is treafured there, and may afterwards be excited independent of the external organ: hence comes the term internal fenfes.

INTERNAL SENSES.

Though I treat profeſſedly of the external organs of the ſenſes only, it may be neceſſary here to ſay a few words on the internal ſenſes. It appears that all ſenſations originate in the external ſenſes or organs receiving the impreſſions of outward bodies; imagination is the power of combining theſe ſenſations, and memory the power of recalling them. Theſe are powers of the mind, which, by the conſtitution of our nature, are gradually acquired, and encreaſed by exerciſe. In infancy, the perceptions are ſimple and tranſitory; the memory is perfected by degrees, and with the ſtore of ideas the imagination is invigorated.

It is in the combination and reciprocal effects of the mental powers and of the impreſſion on the external ſenſes, that we are to find an explanation of the operation of attention. When the mental powers are led to the contemplation of an idea which aſſimilates eaſily with the ſenſation about to be preſented by the external organ, the perception is quick, and the idea vivid; but when the mind is ſtrongly impreſſed and occupied with the contemplation of paſt ideas, the preſent operation of the ſenſe is neglected and overlooked. Thus, the vividneſs of the perception or idea, is always proportionate to the degree of undiſtracted attention which the mind is able to beſtow on the object of ſenſation or of memory. In ſolitude and darkneſs, the ſtrength of the memory in the contemplation of paſt events is encreaſed, becauſe there is no intruſion in the objects of the outward ſenſes; and the deaf or blind receive ſome compenſation for their loſs in the encreaſed powers which are acquired by a more frequent and undiſturbed uſe of the ſenſes which remain, and a keener attention to the ſenſations which they preſent. On the other hand, when we are under the enchantments of a waking dream or reverie, our attention is wholly detached from the preſent objects of the ſenſes; and in this ſtate we may continue to read without underſtanding.

ſtanding. This abſence, in a certain degree, is common, natural, and by no means unpleaſant: It is the exertion of the faculty of the mind. But it may become diſeaſe; for health conſiſts in the due correſpondence betwixt the excitement and the vigorous action of the body, and the operation of the mind when rouſed by the external ſenſes.

The mind (united to the body) ſuffers in the diſeaſes of the body. In the debility of the body, in fever, in ſpaſms, and pain, the faculties of the mind languiſh, or are rouſed to unequal ſtrength or morbid acuteneſs. Sometimes the phantaſms and internal ſenſations of things once received by the outward ſenſes, become ſo ſtrong in the mind, as to be miſtaken for objects actually preſent. Such phrenzy or delirium ariſes from a diſordered and acutely ſenſible ſtate of the internal ſenſes. Theſe impreſſions being great in degree, hurry and buſtle are in the countenance of the patient, and uncommon ſtrength and violence in his actions; as paſſion gives uncommon excitement to one in health, with a diſregard or forgetfulneſs of all other things. In health, however vigorous the force of imagination may be, there is ſtill a conviction that the ideas which it preſents are not realities, and the operation of the external ſenſes preponderates in recalling the attention to what exiſts around us. But when the internal perceptions become ſo ſtrong as to be miſtaken for realities, the effect is falſely attributed to real exiſtences. It indeed ſometimes happens, that this falſe perception is really owing to diſeaſe in the organ; while it alſo occurs, that a too vivid perception of things abſent proceeds from an affection of the brain, and not of the outward ſenſes.

There is ſtill another degree or claſs of diſeaſed ſenſation, conſiſting in the modification of the impreſſion of objects which are actually preſent to the ſenſes. But this modification of things preſent (as when bodies actually at reſt appear to be in motion) is not always occaſioned by optical deception. Objects ſeem to turn round, and this we ſhall afterwards find to proceed from the inſenſible motion of the eyes; but this motion of the eyes is occa-

ſioned by the diſordered ſtate of the internal ſenſation; and the ſame feeling will be experienced if the eyes be ſhut. For example, when we turn quickly round on our heel until we become giddy, it would appear that there is a diſturbance of the uſual order of ſenſation, and that the courſe of our impreſſions is reverſed; for while our ſenſations were formerly directed entirely by the impreſſion made on the outward ſenſes, the ſenſorial impreſſions now draw after them a ſympathetic motion of the external organs.

This inverted communication betwixt the mind and organs is better exemplified in the organ of ſpeech. Thoughts excited in the mind are repreſented by the ſigns of theſe ideas in ſpeech. There occurs, however, not unfrequently, a diſeaſed ſtate of theſe operations of the internal ſenſes, in which the ideas excited in the mind cannot be aſſociated with their appropriate expreſſions; and although the patient has a diſtinct idea of what he means to expreſs, he cannot recollect the words which belong to it; ſo that, when he aſks for one thing, he names another which has no connection with it. Of this he is perfectly ſenſible, and yet he cannot correct himſelf.

There are more frequent inſtances of diſeaſed corporeal ſenſation in hypochondriacs. In them, the ſenſation of pain and unuſual feelings are falſely attributed to parts in which there is really no affection: for theſe feelings there is no apparent cauſe; they proceed from a diſordered ſtate of ſenſation in which the uſual courſe of the impreſſions is altered, ſo as to occaſion the patient falſely to attribute his ſuffering to ſound and healthy parts. Thus indigeſtion, the irritation of the bile, flatulency, colic, &c. often do not give the uſual impreſſions, but the pains are attributed to outward parts. That there is ſometimes an actual connection exiſting betwixt the external parts, to which theſe feelings are referred, and the internal organs, is evident from the fact, that preſſure in the outward and ſound parts has occaſioned ſpaſms in the internal organs. To ſuch diſordered tranſmiſſion of the irritation of the internal parts we have

to

to attribute the extravagant and ludicrous ideas which hypochondriacs entertain. In theſe people, there are diſeaſes of parts, of the action of which, during their healthy ſtate, (as I have already explained in the ſhort introductory view of the nervous ſyſtem,) we have no feeling nor conſciouſneſs, and over which the will has no power. But although in the healthy ſtate of the œconomy there is no immediate route by which any ſenſation from theſe organs can be tranſmitted to excite a mental perception, it may happen, that, in their diſeaſed ſtate, when ſenſations do ariſe which forcibly attract the attention, there ſhould be an obſcurity in the feelings produced by their derangement, inſomuch, that the mind may be deceived in regard to the direction of the ſenſation conveyed from them.

During health, there are viciſſitudes of conſciouſneſs, ſenſe, and voluntary motion, and of reſt from voluntary exertion, inſenſibility, and oblivion of the paſt. This is true, however, only comparatively, and by a groſs reference to degree; for even during natural ſleep there is not a total oblivion of paſt perceptions, nor is there always a total unconſciouſneſs of the preſent, as the ſenſes are in part awake; ſome one train of ideas is preſent to the mind; and the lapſe of time is obſerved. Even theſe perceptions are ſometimes ſo ſtrong as to be followed by voluntary exertion, and yet the patient remains aſleep. Whatever conduces to take the excitement from the mind, or leſſens the vivacity of its impreſſions, conduces to ſleep. Thus, reſt, ſtillneſs, and darkneſs, by excluding the moſt lively impreſſions conveyed by the ſenſes; and hæmorrhagy and evacuations, by leſſening the velocity of the circulation; and cold, by leſſening the ſenſibility; induce ſleep. Again, compreſſion of the returning blood from the head, by giving it a ſlow languid motion, and by depriving the veſſels of their freedom of action, alſo conduces to ſleep; becauſe, as formerly remarked, the powers and faculties of the brain muſt be renovated through the means of the circulation.

By long watching and fatigue, the body is brought nearly to a feveriſh lowneſs. By ſleep, reſt is given to the voluntary muſcles, and an abatement of the vital motions enſues; the quieſcent ſtate of the muſcles brings back the blood to the heart, with a ſlow, regular, and calm progreſſion; the heart is reſtored to its ſlow and equable pulſation; the breathing becomes ſlower; and the waſted ſtrength of the ſyſtem is recruited.

We may define ſleep to be a ſtate in which the ſenſations are dull, the voluntary muſcles inert, and the vital motions calm and regular. In dreaming, the ſenſations are dull and obſcure, but the imagination more alive and active; unnatural ſleep, or ſoporific diſeaſes, may be characterized by the diſordered imagination, and diſturbed vital and voluntary motions. The vital actions, which are calm, ſlow, and equable, during natural ſleep, become oppreſſed; the ſenſibility, which is gradually diminiſhed upon the approach of ſleep, but always capable of being rouſed by the ſenſes, becomes quite oppreſſed; the voluntary muſcles continue relaxed, as in ſleep, or convulſed by irregular motions. In the oppreſſion of the night-mare, we have the conſciouſneſs of ſenſation, but the power of motion is loſt. In apoplectic diſeaſes, the functions of the viſcera proceed, and are but partially impeded; but when the circulation of the blood and play of the lungs are obſtructed, the operations of the mind are not equally unconcerned in the paroxyſm; for in ſyncope, the ſudden depletion of the blood-veſſels of the brain cauſes inſtant loſs of ſenſe and of voluntary motion.

If natural ſleep is not profound, the imagination is awake; but there may be falſe perceptions, falſe judgment and aſſociations, and diſproportionate emotions; and if ſenſations are perceived, they do not produce the ordinary aſſociations. If ſuch a ſtate of the intellectual functions occurs during the waking ſtate, it becomes delirium. That this delirium is analogous to the perturbed ſtate of the imagination during ſleep, appears from the delirium in fevers uniformly ſhowing its ap-

proach

proach in the patient's ſlumbers only. It is a diſpoſition to form falſe images and aſſociations, which, in the beginning, the excitement of the outward ſenſes has power to counteract, inſomuch that a patient can be rouſed from delirium as he can be rouſed from ſleep; but, by and by, the external ſenſes loſe their ſuperiority, and their excitement is attended with unuſual aſſociations; they no longer convey impreſſions to the intellect, but become ſubſervient to and modified by it, and the judgment, which depends on the due balance of memory and imagination, is loſt. In fever, the delirium is tranſitory; in low fevers, it is combined with a comatoſe ſtate. In melancholy, the delirium runs upon one object chiefly, or trains of ideas, which refer to the patient's health and corporeal feelings. In madneſs, the variety is infinite; but chiefly conſiſting in a vitiated imagination and perverted judgment, with fierceneſs and encreaſed power of corporeal exertion.

There are five organs peculiarly adapted to convey ſenſations to the mind; or as I am more inclined to ſay, to rouſe the faculties of the mind by exerciſing the internal organs of the ſenſes in the brain; theſe may be conſidered as forming a medium of communication betwixt the external creation and the ſentient principle within us; they are at the ſame time the bond of union betwixt ſentient beings. Theſe organs are called the EXTERNAL SENSES; viz. the ſenſe of ſeeing, the ſenſe of hearing, the ſenſe of ſmelling, the ſenſe of taſting, and the ſenſe of touch. Individually, theſe organs convey little information to the mind; but by compariſon and combination, the ſimple and original affection or feelings received from them are aſſociated and combined to infinity, and adminiſter to the memory and imagination, to taſte, reaſoning, and moral perception, the paſſions and affections, and every active power of the ſoul.

BOOK I.

OF THE EYE.

CHAP. I.

INTRODUCTORY VIEW OF THE PRINCIPLES OF OPTICS.

LIGHT is a matter thrown out from ignited, or reflected from ſhining, ſurfaces; and which enters the eye, and impreſſed on that organ gives the ſenſation of ſight. The ſun is the greateſt ſource of light, and perhaps the original and only ſource. The minuteneſs and inconceiveable velocity of light, the facility with which it penetrates bodies of the greateſt denſity and cloſeſt texture, without a change of its original properties, makes it the ſource of the moſt wonderful and aſtoniſhing phænomena in the phyſical world.

The ſmalleſt ſtream of light which propagates itſelf through a minute hole, is called a ray; and, as rays of light paſs through a uniform medium in a ſtraight courſe, they are repreſented by mathematical lines. But light is not uniform in reſpect of colour; every part of a ray is not capable of exciting the idea of whiteneſs which the whole raiſes. White light is compoſed of different kinds of rays, which individually give the ſenſation: one of red, another of orange, a third of yellow, a fourth of green, a fifth of light blue, a ſixth of indigo, and a ſeventh of a violet or purple *. Theſe are named the priſmatic colours;

* There is a fact not a little extraordinary regarding the emanation of rays from the ſun, and which has been diſcovered in the preſent day, viz.

colours; because, in the spectrum produced by making a ray of light to pass through a prism, these several colours are seen in the succession in which they are above enumerated. Each of these rays individually impresses the eye with its own colour; but when they all impress the eye at once, the sensation upon the organ of sight is a compound effect: no individual colour is presented, but that mixed light which is called whiteness, and which may be divided into its individual colours by passing it through a prism.

It is the nature of most bodies to absorb some of these rays of light and to reflect others from their surface; consequently, the colours of bodies depend upon the particular rays which are reflected from them, or upon the combination of such rays as are reflected from them; and a body appears of that colour of which the light coming from it is chiefly composed.

When a ray of light passes from a rarer to a denser medium, or from a denser into a rarer, it alters its course, if there be any obliquity in the original direction; but if it strikes from one medium into another perpendicularly to the surfaces, its original direction is not changed. If the ray passing from the air enters obliquely into glass or water or any denser medium, it turns more towards the perpendicular; but if it passes through the glass and emerges again into the air, it resumes its original direction, diverging from the perpendicular. This effect of different mediums upon the ray of light, is called refraction: when a ray of light impinging upon a surface does not enter, it rises again to the angle of its incidence; and this is reflection.

The prism is a piece of glass of a triangular form; the inclined surfaces of which, when placed in the course of the ray of light, refract, and separate the se-

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viz. that there are invisible rays, giving heat but no light, which are less refractable than the coloured rays; and that all rays, in proportion to their refrangibility, have less power of producing heat. See Herschel on the invisible rays of light. Phys. Trans. 1800, part ii. p. 284.

veral

veral parts of the heterogeneous ray, and ſhow its compound nature. If the ſun be permitted to ſhine into a dark room through a ſmall hole in the window-ſhutter, and the beam of light be made to fall upon a glaſs priſm, it is, in paſſing through the glaſs, ſeparated into its conſtituent parts; becauſe the ſeveral coloured rays have different degrees of refrangibility, in the order in which I have already enumerated them. If the rays, after paſſing through the priſm, be made to paſs alſo through a convex glaſs, they are brought again to a point in the focus of that glaſs; and the effect of the whole colours thus reunited, is perfect whiteneſs. We might ſuſpect that the beams of light were homogenous, and that the degree of refraction gave different colours to the rays, were it not proved, that how much ſoever any of the coloured rays is further refracted, it does not change its nature: nor will rays ſuffer any change by reflection from bodies of different colours, for minium will appear yellow, green, blue, &c. according to the colour of the ray of light directed upon it †.

As the impreſſion of light remains ſome time upon the nerve of the eye, it gave Sir Iſaac Newton the opportunity of examining, whether each coloured ray makes a diſtinct impreſſion on the eye, or whether they ſo affect each other as to impreſs the ſenſe of whiteneſs on the eye. When a burning coal is whirled in a circle, the eye perceives an entire circle of fire, becauſe the impreſſion made by the coal in any point of the circle remains until the coal returns again to the ſame place, and renews the ſenſation. When all the varieties of colours are painted in a circle, and turned in the ſame way with the burning coal, they muſt each make their ſeparate impreſſion upon the optic nerve; but the general ſenſation is whiteneſs; or when the teeth of a comb are drawn acroſs the ſtream

† It is found, that the coloured rays have not all the ſame power of illuminating objects; the orange ray poſſeſſes this property more than the red; the yellow more than the orange, &c.; and the maximum of illumination lies in the brighteſt yellow or paleſt green; nor do the ſeveral rays equally affect the thermometer. See Herſchel's Exp. Phyſ. Tranſ. 1800, p. ii. p. 255.

of

of light iſſuing from a priſm, the different colours are intercepted in ſuch quick ſucceſſion, that a perfect whiteneſs is the reſult of the mixture of impreſſions. There are many experiments which ſhow, that the inequalities of the refraction of light are not caſual; that they do not depend upon any irregularity of the glaſs: on the contrary, it is proved, that every ray of the ſun has its own peculiar degree of refrangibility, according to which it is more or leſs refracted in paſſing through pellucid ſubſtances, and always in the ſame manner: and, laſtly, that the rays are not ſplit and multiplied by the priſm.

When a ray of light falls upon the ſurface of glaſs obliquely, it inclines to a line drawn (through the point of incidence) perpendicular to the ſurface.

Fig. 1.

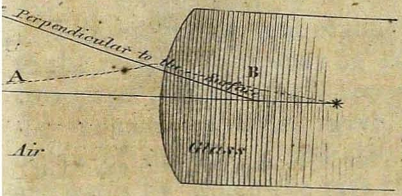
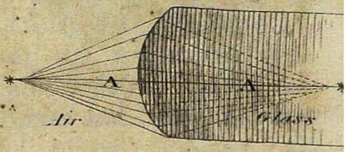


Fig. 2.



Thus the ray A. fig. 1., proceeding from the object *, is refracted upon entering the maſs of glaſs in the direction B, having a tendency towards the perpendicular line. By this means, if a number of rays proceeding from any one point, as in fig. 2., fall on a convex or ſpherical ſurface of glaſs, they will be inflected ſo as to gather about the perpendicular line A A in the centre of the glaſs: which perpendicular line is the axis of the glaſs. If the rays of light proceeding from an object to be made to ſtrike into a maſs of glaſs with a concave

concave ſurface, the obliquity with which they impinge upon the ſurface, being the reverſe of the convex ſurface, they are not made to converge upon the central line, but diverge from it.

Farther, the rays of the ſun when paſſing from a medium of glaſs into the air, are turned, by refraction, farther off from the central line to which they were drawn in entering the convex ſurface of glaſs. But if the rays, in paſſing through the glaſs, were in a direction converging to the perpendicular line, they will be made to converge ſtill farther, as is ſeen here in fig. 3.

Fig. 3.

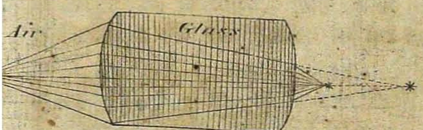
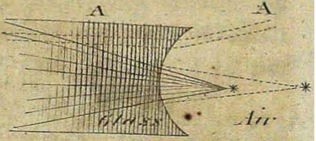


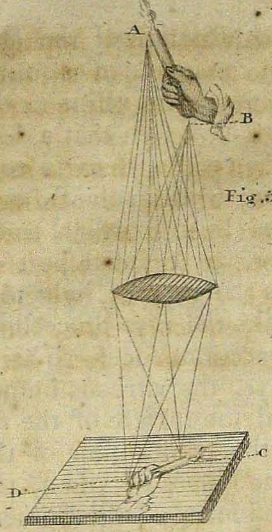
Fig. 4.



If, however, the rays be made to paſs from glaſs into the air, and the ſurface of the glaſs be concave as in fig. 4., the rays will be made to have a leſs degree of convergence, ſo as to remove the image * farther from the ſurface of the glaſs. But if the rays paſſing through the medium of glaſs have no convergence, but paſs in parallel lines, they will diverge as the lines A A, fig. 4. do, when they emerge from the concave ſurface of the glaſs.

We ſee, then, the operation of a double convex glaſs, in forming the image of a luminous body upon a ſurface. If, for example, ſuch a glaſs be held between a candle and a piece of white paper, (the diſtances being properly adjuſted,) the image of the candle will appear very diſtinctly upon the oppoſed ſurface, but inverted;

becauſe



because the rays coming from the point A fig. 5., converge at C, and those from the point B at D.

Before proceeding farther in this short exposition of the principles of optics, it will be necessary to take a very slight view of the structure of the eye.

SIMPLE IDEA OF THE STRUCTURE OF THE EYE.

THE eye being that organ by which we are sensible to the rays of light, may be considered as consisting of two parts; that which receives the impression, viz. the retina or expanded nerve, and which is indeed the organ of the sense; and the tunics and humours, the apparatus by which the rays of light are combined and made capable of giving an impression to the retina, or proper organ of the sense.

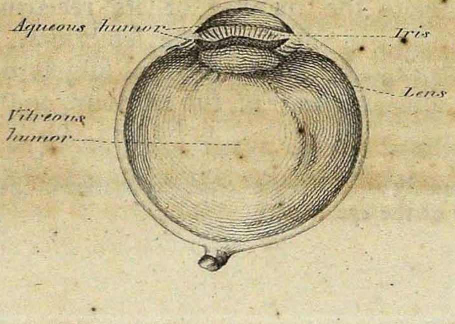
In an anatomical enquiry, it is chiefly the latter division of the subject which must occupy our attention; for, although we are necessarily led to consider the nature of the substance of the retina, the manner in which it is expanded, and supported by adhesion, and nourished by vessels, we must not venture far in the attempt to investigate the manner of its receiving or conveying the image of objects to the sensorium. We must turn to investigate the more useful subject of the structure, use, and diseases † of the humours and coats of the eye.

† Of the diseases only as they relate to the explanation of the structure and œconomy of the eye.

It

It is the firſt principle of the conſtitution of the eye, that the rays of light muſt be ſo concentrated as to impinge ſtrongly on the expanded nerve or retina in the bottom of the eye. Now, as we have ſeen that a lens (which is a double convex glaſs) is neceſſary, ſo to concentrate the rays of light proceeding from an object, as to form a ſmall and lively image of it (as in marginal plate, fig. 5.), ſo, in the ſame manner, an eſſential part of the eye is the lens, which brings the rays of light to a focus; and that the lens may make the rays proceeding from an object converge into an accurate focus, ſo as to form a diſtinct image on the eye, the vitreous humor is interpoſed betwixt the lens and the ſurface of the retina: again, it is neceſſary to the conſtitution of the eye, that, in order to increaſe the ſphere of viſion, the anterior part of it ſhall project and form a large ſegment of a ſmall circle, ſo as to take a greater circumference into the ſphere of viſion than could have been done, had the larger ſphere of the eye-ball been continued on the fore part. Another neceſſary part of the apparatus of the eye is the iris, which is a curtain in the anterior chamber of the eye, perforated with a hole, which is capable of being enlarged or diminiſhed ſo as to admit a larger or ſmaller ſtream of light according to the intenſity of the light. In this proviſion, we ſee the neceſſity of the anterior humor of the eye being different from the others; being merely an aqueous ſecretion, while the others poſſeſs a degree of firmneſs, viz. that the iris or curtain of the eye, may move with perfect freedom in it.

Fig. 6.



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The three humors of the eye are thus ſituated, and have this general character:

1. The AQUEOUS HUMOR is the anterior humor of the eye. It diſtends the anterior and pellucid part of the eye, ſo as to encreaſe the ſphere of viſion. It is perfectly fluid, and of a watery conſiſtence, that it may allow free motion to the iris.

2. The LENS OF CHRISTALINE HUMOR is placed immediately behind the perforation in the iris; which perforation is called the pupil. The lens collects the rays of light like a double convex glaſs, ſo as to concentrate them, and make a more forcible image on the bottom of the eye.

3. The VITREOUS HUMOR is behind the lens. It diſtends the general ball of the eye into a regular ſphere, that it may move eaſily in the orbit; and its diameter in the axis of the eye is ſo proportioned to the focal diſtance of the lens (affected alſo in ſome degree by the other humors), that the image of an object is formed accurately on the ſurface of the retina; accordingly, when the coats are cut from the back of the eye, the picture of a luminous object held before the pupil is ſeen exquiſitely minute and diſtinct on the bottom of the eye.

While theſe humors have each its diſtinct character, they poſſeſs in proportion to their denſity, different powers of refracting the rays of light. This has the ſtill farther good effect of correcting the aberration of the rays and giving the trueſt colours, as well as the moſt correct image of the object preſented to the eye.

If the lucid anterior part of the eye be formed too prominent, or if the lens of the eye have too great a degree of convexity, or, laſtly, if the ſize of the ball of the eye, and the diameter of the vitreous humor in the axis of the eye be unuſually great, then the perſon does not ſee diſtinctly; becauſe the powers of the humors, in concentrating the rays of light, are too great, and the image of the object is not formed accurately

on the retina, but before it. Thus, in fig. 7., the convexity of the cornea, the lucid anterior part of the eye, or the focal powers of the lens, being too great for the length of the axis of the eye, the image is formed at A before the rays reach the ſurface of the retina; and after coming accurately to the point, they again begin to diverge; which diverging rays, ſtriking the ſurface of the retina, give the indiſtinct viſion of a near-ſighted perſon. But as this indiſtinctneſs of viſion proceeds from no opacity, but only the diſproportion of the convexity of the eye to the diameter, the defect is corrected by the concave glaſs, A fig. 8.; for, the effect of this glaſs being the reverſe of the convex, it cauſes the rays to fall upon the ſurface of the eye, ſo far diverging from the perpendicular line, (which is exemplified in fig. 1.), as to correct the too great convergence cauſed by the convexity of the humors. But, when a near-ſighted perſon has brought the object near enough to the eye to ſee it diſtinctly, he ſees more minutely, and, conſequently, more clearly; becauſe he ſees the object larger, and as a perſon with a common eye does, when aſſiſted with a magnifying glaſs or convex lens.

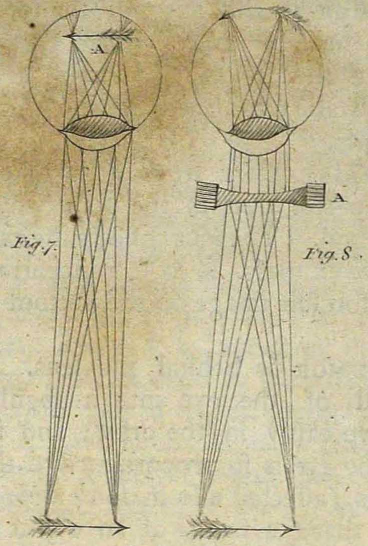


Fig. 7. Fig. 8.

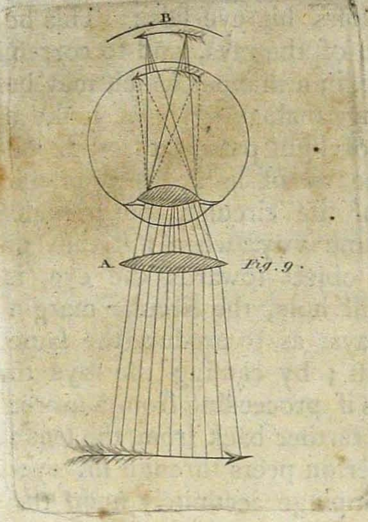
The near-ſighted perſon ſees diſtant objects indiſtinctly; and as the eye, in conſequence, reſts with leſs accuracy upon the ſurrounding objects, the piercing look of the eye is diminiſhed, and it has a dulneſs and heavineſs

nefs of afpect. Again, the near-fighted perfon knits his eye-brows, and half clofes his eye lids: This he does to change the direction of the rays, and to correct the inaccuracy of the image, in a manner which may be underftood by the following analogy. If we make a card approach a ftream of light paffing through the window, it will fo attract the rays of light, as to extend the margin of the figure of the circular fpot of light upon the wall. In the fame way, when a ftream of light, proceeding from an object towards the eye, is made to pafs through a fmall hole, the circular margin of the hole fo attracts the rays, as to produce the fame effect with the concave glafs; by caufing the rays to take a direction outward, as if proceeding from a nearer object, the image is carried farther back from the lens; and when a near-fighted perfon peers through his eye-lids, it makes the rays impinge accurately upon the retina *.

The effect of old age, is gradually to reduce the eye to a lefs prominent ftate, and, confequently, to bring it to the reverfe of the near fighted eye.

From the decreafe of the humors, and the leffened convexity of the cornea, the image of objects is not formed foon enough to impinge accurately on the retina, the rays tend to form the image behind the retina, as we fee in fig. 9.

* Short-fightednefs may be produced by accidents. Once I have known it produced by a piece of glafs fticking in the cornea, and caufing great inflammation. Dr. Briggs mentions the cafe of an old man, who had long ufed fpectacles, becoming fuddenly fhort-fighted, by catching cold, and he was afterwards enabled to read the fmalleft print without glaffes. In general, however, it is by fome accident, and often not till manhood, that we become fenfible of being fhort fighted; and, in this cafe, men are very apt to attribute the defect to fome particular occurrence.



In this figure, we have the effect of old age on the humors reprefented: without the intervention of the glafs A, the rays have a direction which would form the image at fome diftance beyond the retina, as at B. But by the convex glafs A (which is of the nature of the common fpectacles for old people) the direction of the rays of light is fo corrected, that the image falls accurately on the bottom of the eye.

We underftand, then, whence thefe oppofite defects of fight arife; that, in old people, objects cannot be feen diftinctly when near, and, in fhort-fighted people, they cannot be feen diftinctly when at a diftance. We fee, alfo, why old age corrects fhort-fightednefs by gradually reducing the convexity of the eye, enabling the perfon to fee objects farther removed, until, by degrees, he comes to fee perfectly at the diftance moft convenient for the common affairs of life.

It has been, by fome, thought extremely difficult to account for the image appearing to us, as it is in nature, erect, fince it is actually figured on the bottom of the eye in an inverted pofture; but the terms above and below have no relation to the image in the bottom of the eye, but to the pofition of our bodies and the furrounding things. When I look to a tall man's face, I direct my eyes upwards; I obferve his fituation, as it relates to an ideal area before my eye, or to a fpace in the fphere of vifion.

When an object approaches towards the eye, the diameter of the picture on the retina encreafes in the fame proportion as the diftance between the eye and the ob-

ject

ject decreaſes; and, conſequently, it decreaſes in the ſame proportion as the diſtance encreaſes. But the degree of brightneſs of the picture of an object on the retina continues the ſame at all diſtances, between the eye and the object, unleſs ſome of the rays of light are interrupted in their progreſs; for, as the advancing object becomes bright, it encreaſes doubly in length and breadth, or quadruply in ſurface. The faint appearance of remote objects, therefore, is occaſioned by the opacity of the atmoſphere.

There is nothing more aſtoniſhing in the ſtructure of the eye, than the ſenſibility of the expanded nerve, as proved by the extent of the changes or degrees of light which illuminate viſible objects; or the great degree of light which the eye can bear, and the low degree of light at which objects are viſible. Thus, the proportion betwixt the degrees of light illuminating an object by the ſun, and by the moon, at any equal altitudes, is calculated at 90,000 to 1 *. Again, by M. de la Aire's calculation, we ſee the ſail of a wind-mill, ſix feet in diameter, at the diſtance of 4000 toiſes. The eye being ſuppoſed to be an inch in diameter, the picture of this ſail, at the bottom of the eye, will be $\frac{1}{8000}$ of an inch, which is the 666th part of a line, and is about the 66th part of a common hair. This gives us an idea of the minuteneſs of the ſtructure of the optic nerve.

The pupil of the eye is formed by the central perforation in the iris or curtain, which hangs before the lens. This body having muſcularity, is moveable; it dilates or contracts the hole or pupil, tranſmitting the rays ſo as to adapt the diameter of the ſtream of light, darting into the eye, to the intenſity or degree of light. If a body is illuminated but faintly, the pupil is (inſenſibly to us) enlarged, and a greater quantity of the rays are allowed to be tranſmitted to the retina. But as the convexity of the pellucid part of the eye, and the concentrating powers of the lens, remain the ſame, the ſize of

* See Smith's Optics, vol. i. p. 29.

the image is not altered by this dilatation of the pupil, but only the ſtrength of the image or picture in the bottom of the eye is encreaſed.

We underſtand that the rays of light are refracted, when they paſs out of one medium into another of different denſity. — For example, the rays of light are refracted towards the perpendicular line, when they enter the cornea of the human eye; but they will be refracted in a very ſmall degree in entering the cornea of fiſh, becauſe the aqueous humor is of the ſame denſity with the fluid from which the rays of light are tranſmitted; accordingly, the cornea of fiſhes is not prominent: this would limit their ſphere of viſion, were not the flatneſs of the cornea counteracted by the prominence of the whole eye, and the more anterior ſituation of the chryſtalline lens; a large pupil and long diameter of the eye we ſhall afterwards find to be neceſſary to the diſtinct viſion of fiſhes*.

It is natural, on the preſent occaſion, to inquire into the effects of the ſeveral humors of the eye, in producing in thoſe who are ſhort-ſighted, the obſcurity ariſing from the double appearance of ſmall and ſhining points. This is prettily explained by Jurin, upon Sir Iſaac Newton's principle, concerning the fits of eaſy refraction and reflection of light.

The horns of the new moon, or the top of a diſtant ſpire, or the lines upon the face of a clock, appear double or tripple, and ſometimes much more multiplied, to a ſhort-ſighted perſon. The ſame appearance will be given when an object is held too near the eye, for perfect viſion. If the light is ſeen through a narrow ſlit in a board, and the board is brought nearer to the eye

* Neither fiſh out of water, nor other animals within water, can ſee any object diſtinctly. Divers ſee objects as an old man would do through a very concave glaſs put near to the eye; and it has been found, that the convexity of ſpectacles for divers in the ſea muſt be that of a double convex glaſs, equal on both ſides to the convexity of the cornea. The neceſſity of this is plain; the aqueous humor of the eye being of the ſame denſity with the water, there is no refraction of the rays in paſſing from the water into the eye, and this deficiency muſt be ſupplied.

than

than the point of diſtinct viſion, the aperture will appear double, or as two luminous lines, with a dark line between them; and as the diſtance is varied, two, three, four, or five dark and luminous lines will be obſerved. There are many ſuch deceptions in viewing luminous bodies; all of them proceed from the ſame cauſe, which is this: — Before Sir Iſaac Newton's philoſophy was acknowledged, it was the received opinion, that light was reflected from the ſurface of bodies by its impinging againſt their ſolid parts, and rebounding from them like a tennis-ball when ſtruck againſt a hard and reſiſting ſurface: further, as they ſaw that part of the rays of light were in glaſs reflected, and the reſt tranſmitted, they conceived that part entered the pores of the glaſs and part impinged upon its ſolid parts. But this does not account for the refractions which take place when the rays have paſſed the glaſs, and are about to be tranſmitted into the air, they cannot find ſolid parts to ſtrike againſt in entering the air, for the refraction of the light is greater in paſſing from the glaſs into the air, than from the air into the glaſs; and if water be placed behind the glaſs, the refraction of rays paſſing out from the glaſs is not encreaſed but diminiſhed, by this ſubſtitute for the rarer medium of the air. Again, when two glaſſes touch each other, no refraction is made in rays paſſing from the one into the other. To explain this, Sir Iſaac Newton taught, that in the progreſs of rays of light, there is an alternation of fits of eaſy tranſition or reflection; or, in other words, that there is a change of diſpoſition in the rays, to be either tranſmitted by refraction, or to be reflected by the ſurface of a tranſparent medium. Jurin illuſtrates this opinion, and its application to our preſent purpoſe, in this manner.

 Suppoſe

Suppose that A B D, and B D F, are mediums of different density, and that their surfaces are intersected by the line B D; again, let A be a pencil of rays, which, issuing from this point falls upon B *a* D, as the refracting surface B *a* D is convex, and no two points of it, from *a* to D, are equally distant from the source of the rays A; and, as the rays of light, in their progress, alter alternately from the fit of refraction to the fit of reflection, they must be in part refracted to the focus F, and reflected in the direction of the dotted lines C *e*. Thus, if the ray A *a* happens to be in disposition to pass through the medium B D F, it will pass on towards the point F. If the next ray A *b* should be in no fit to be transmitted, because, being in a degree farther advanced from its source A, it has changed to the fit of reflection, then it will not be refracted towards the focus F, but reflected off towards *c*; but, again, the ray A D being advanced farther from its source, it will impinge upon the surface B D, during its disposition to refraction, and will concentrate its beams at F; and so with all the others, alternately reflected and refracted.

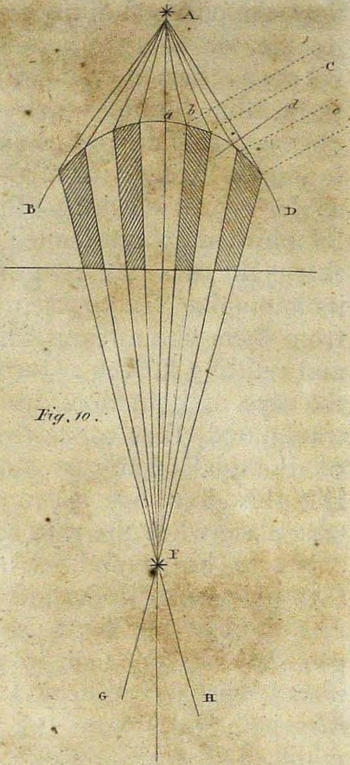


Fig. 10.

The consequence of this obstruction to the equal refraction of light, is, that the image formed at F is feeble; but still it is distinct and perfect; because the transmitted rays are regularly concentrated, and form the proper focus. But if the converging rays should be

be received upon a plain before they arrive at the focus F, the reflected rays of light will have left spaces dark where they would have fallen by refraction, and, consequently, distinct luminous circles will be thrown on the plain: again, if the plain surface be opposed to the rays, after they have formed their focus, and are again dispersing after having crossed, the same unequal effect of light and dark circles will be thrown on it; though now, the rays of the right side of the pencil B D F, will form the left of the pencil F G H.

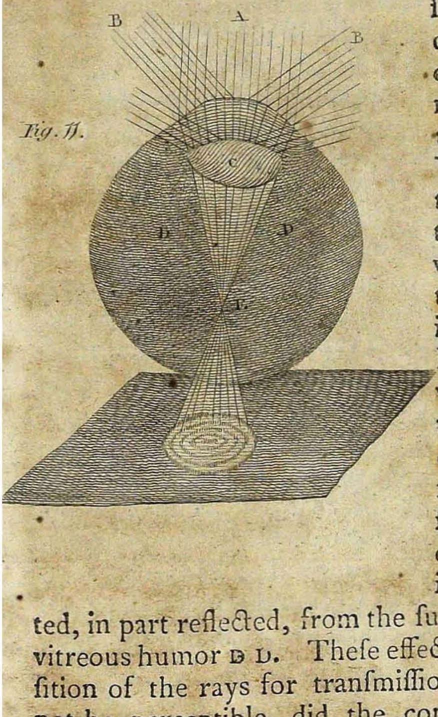


Fig. 11.

How the changeable state of the rays produces the indistinctness of the near-sighted eye, may be understood from this (II.) diagram.—When the rays A strike the convex surface of the cornea, part of them will be reflected from the surface of the cornea, in the direction of the lines B B, when they will consequently strike upon the convex surface of the lens in luminous rings, these rings will be still farther multiplied and diminished in diameter, in being in part transmitted, in part reflected, from the surface of the lens c, and vitreous humor D D. These effects of the alternate disposition of the rays for transmission and reflection would not be perceptible, did the converging powers of the cornea and lens bring the focus of the rays exactly to the surface of the retina; but as the focus is formed at E, some way before the retina, the rays have decussated and spread out again before they form the image upon the bottom of the eye. Instead, therefore, of forming an

an accurate image, they are ſpread out into concentric circles; or in a leſſer degree, the perſon experiences a confuſed outline of the object, which becomes ſurrounded with ſeveral rings or falſe outlines *.

CHAP. II.

OF THE COATS OF THE EYE.

SPEAKING generally, and without conſidering the minuter diviſions of anatomiſts, we may ſay, that there are three proper coats of the eye, viz. the SCLEROTIC COAT, giving ſtrength; the CHOROID COAT, being the vehicle of the chief vaſcular ſtructure of the eye; and the RETINA, or expanded nerve, being the organ itſelf. Theſe are the proper coats of the eye; but there are others which may be called the partial or acceſſory coats, being thoſe which do not completely ſurround the eye, viz. the ALBUGINEA and CONJUNCTIVA†. There are others, ſtill, which are called capſular coats; and theſe are the tranſparent tunics which immediately ſurround the humors, as the capſule of the lens and pellucid membrane of the vitreous humor.

Although many of theſe coats may be capable of being divided by the art of the anatomiſt, either by the knife, by injections, which form extravaſation between their layers, by maceration, or by the chemical action of fluids; yet it is better, in a general enumeration, to take a natural diviſion and character, than to enumerate their ſeveral lamina.

* By *fits of eaſy tranſition*, it was not meant by Sir Iſaac Newton that the rays muſt neceſſarily be tranſmitted through every pellucid medium, and at any obliquity of incidence, but only that the ray was more eaſily tranſmitted, and more difficultly reflected; nor was it meant that, during its *fit of eaſy reflection*, it was abſolutely incapable of being tranſmitted, but only more readily reflected than tranſmitted.

† Colombier, Sandifort Theſ. Diſſert.

OF

OF THE SCLEROTIC COAT.

The ſclerotic coat is ſo called from its hardneſs *. The ſclerotica and cornea are often conſidered as one continued coat inveſting the eye; hence they ſay, the opaque and the lucid cornea. But, although theſe parts are actually in union, yet as they are really of ſo very different a nature, we muſt conſider them apart, and treat at preſent only of the opaque white ſclerotic coat.

The ſclerotic coat is a ſtrong, firm, and white membrane, conſiſting of lamellæ firmly attached and interwoven, and not capable of being regularly ſeparated by maceration; it has the denſeneſs of tanned leather. In firmneſs, whiteneſs, opacity, and the little appearance of vaſcularity, it more reſembles the dura mater than any other membrane of the body.

In adults, the ſclerotic coat is ſtronger and firmer, comparatively, than in the fœtus; the cornea leſs ſo. On the outer ſurface, it has (towards the orbit) a looſe cellular membrane attached to it, which allows the motion of the eye-ball. Upon the fore part it is inveſted by the tunica albuginea or tendinea. Upon its inner ſurface, it has a looſe and ſoft membrane which connects it with the choroid coat.

In birds, and the tortoiſe, the poſterior part of the ſclerotic coat is thin; the fore part of it is ſplit into laminæ, betwixt which there are interpoſed thin plates of bone †, while in fiſhes it is in part cartilaginous ‡, but thin and tranſparent, ſo that there appears a very beautiful ſpotted coat beneath it. There are alſo ſeen in the ſclerotic of fiſhes little white granules like glands.

The vagina of the optic nerve can be ſeparated into two laminæ §; the outer one is obſerved to unite intimately

* Dura ſeu ſclerotica; Veſalius, Ruyſch, &c.

† Cuvier, vol. i. p.387.

‡ Morgagni Epiſt. An. xvi. 40. Cuvier, 383.

§ Ruyſch, Zinn.

mately with the outer part of the ſclerotic coat, while the inner lamina of the vagina is contiguous with its inner ſurface. The pia mater, too, ſays Zinn, when it has pierced the foramen in the ſclerotic coat, alongſt with the ſubſtance of the nerve, expands upon the inner ſurface of this coat, and extends even to the cornea, and forms one of its intimate laminæ. This muſt be only that part of the pia mater which inveſts the optic nerve, or, more ſtrictly ſpeaking, that membrane which ſtands in the ſame relation to the nerve that the arachnoid coat does to the brain; for the membrane, which ſinks into intimate union with the nerve, accompanies it even in forming the retina *.

The ſclerotic coat is the great ſupport of the globular figure of the eye; it defends the more delicate internal ſtructure from ſlighter injuries, by its ſtrength; and from the progreſs of inflammation, by being of a ſtructure but little vaſcular, and not prone to diſeaſe. That inflammation which we ſee to be ſo frequent in the eye, is not in the ſclerotica, but in the adventitious coat, the conjunctiva. But in proportion as the ſclerotic coat reſiſts preſſure and the progreſs of diſeaſe from without, it reſiſts the ſwelling of the parts within when they become diſeaſed, and gives the greateſt torture.

* It may be well, in this place, to detail at once the opinions of the chief ſupporter of that ſcheme of the coats of the eye, which derives them all from the inveſting membranes of the brain and optic nerve. M. le Cat, in his *Traité des Sens*, deſcribes them thus: — When the optic nerve has entered the orbit, the dura mater which ſurrounds it, ſplits into two laminæ; the external one attaches to the orbit, and forms the perioſteum, the other forms the vagina of the nerve. In the angle formed by theſe, the muſcles of the eye ariſe. This continued ſheath of the nerve, (he continues,) expands into the globe of the eye, as the maſs of glaſs is blown into a bottle. The dura mater of the nerve is expanded into the cornea (viz. ſclerotica). The ſecond envelope, or pia mater, forms two laminæ: the one is applied to the ſclerotic coat, and the other forms the choroid coat. The choroid coat divides anteriorly, and forms the iris and ciliary proceſſes. The internal medullary part of the optic nerve forms the retina. Finally, "L'œil eſt tres evidemment l'extremité nerveuſe "epanouie bourſouflée en bouton creux & plein de liqueurs." p. 158. See alſo *Bonn* Sandifort Theſaur. de continuatione membranæ.

Of

Of what importance the entireneſs of the coats, and the uniform reſiſtance of the humors of the eye is to the healthy ſtate of the organ, will be afterwards examined.

OF THE CORNEA.

The cornea is ſo called, from being firm, tranſparent, and compoſed of laminæ *. It is the pellucid circle on the fore part of the eye, which ſeems variegated with colours; though this is a deception, owing to its perfect tranſparency. The circle of the cornea is, however, far from being regular; its margin is flat towards the noſe.

The cornea conſiſts of laminæ; betwixt which, there is interpoſed a cellular ſubſtance, filled with a perfectly pellucid fluid †. Theſe cells ſeem, like the common cellular membrane of the body, to have a free communication with each other, ſo that the fluid freely exudes, and as quickly is imbibed by maceration. The fullneſs of the cornea, with the perfect tranſparency of the fluid, gives a brilliancy to the eye, and is a ſign of health; the reverſe dims the eye, and with the fallen features, accompanies ill health. Steno obſerved, and Petit confirmed, the fact ‡, that the pores on the ſurface of the cornea exuded the fluid which fills the cells of the cornea; and that, after the ſurface was carefully dried by preſſure, the moiſture might be ſeen to form in drops upon the ſurface. The moiſture can be thus forced out from the pores of either ſurface of the cornea §. This moiſture becomes dull and clamy on the approach of death, and forms ſometimes a pelicle over the cornea. The laxity with which the laminæ of the cornea are connected, may be, in ſome meaſure, demonſtrated, by taking it betwixt the finger and thumb; we ſhall then find, that the layers can be made to glide very freely on each other. In the fœtus, and

* "Cornu modo dura, & cornu inſtar in laminas dividiradique "poteſt." Veſſalius.

† Subſtantia ſpongioſa Valſalvæ.

‡ See alſo Hovius, p. 82.

§ Zinn.

in young children, the cornea is of great thicknefs, and refifts the point of the lancet or fciffars. This refiftance in the fœtus proceeds from a great degree of toughnefs, while, in the adult, the furface of the cornea is fo hard, that I have often feen the point of the knife, in extracting the cataract, bend upon it. This turning of the elaftic point of the knife is very apt to give a wrong direction to the incifion; and, indeed, this ocurred to me in my firft operation.

There is a pelicle, or exceedingly thin coat, which, by maceration, can be taken off from the furface of the cornea. This is generally underftood to be the conjunctiva continued over it. But I cannot help expreffing myfelf as averfe to the ideas of thofe anatomifts who confider every membrane, which can be traced from another by diffection, as either derived from it, or in any way allied to it. This can furely ferve no ufeful purpofe, if, as here, the membranes differ in their ufe; are changed in their appearance; and have no fimilarity in ftructure, function, or difeafes.

The membrane in fifhes, analogous to the adnata, lies loofe over the cornea; and, in ferpents, it is thrown off from the cornea, with the fcales of the body, and remains attached to the caft fkin of the head; and in the fœtus calf, I have forced the blood in the veffels of the conjunctiva into veffels paffing over the furface of the cornea.

By maceration, I have found, raifed in the fluid, a very delicate and tranfparent membrane from the inner furface of the cornea*; and, after long continued foaking, the whole cornea can be taken out of the fclerotic coat, like an optician's glafs from its frame.

The cornea poffeffes great fenfibility; although much of the pain, from hard bodies flying into the eye, is to be attributed to the motion of the eyelids, and the great fenfibility with which they are endued. When a fplinter of glafs or metal ftrikes and fticks in the cornea, inflam-

* This, within thefe two years, has been claimed as a difcovery. I fear that this muft be confidered as the capfule of the aqueous humor, long fince defcribed.

mation is excited; in consequence of this, vessels carrying red blood strike into it, or shoot over its surface in a new film of membrane *. Petit thought he observed first in a negroe, and afterwards in a variety of instances red lines in the cornea; which he conceived to be the anastamosing of vessels. There are, besides, says he, many circumstances which argue that there are blood-vessels in the cornea. When the eye receives a stroke, there is often blood effused in its substance; abscesses, also, are found within it, and phlyctænæ on its surface; and in great inflammation of the eye, the cornea appears red; which, he supposed, must be produced by the same cause which makes the albuginea red, viz. the enlargement of its vessels, and the circulation of red blood. But we must not imagine, he continues, that, in the natural state, red blood circulates in the cornea; for the vessels are not to be seen with the microscope; nor are they penetrated by injection; nor do they appear in the fœtus; nor, when little abscesses are formed in the cornea; but only when violence has been done by a stroke upon the eye. In an eye in which the tunica conjunctiva was most minutely injected, as well as the internal vessels of the eye, I had resolved carefully to examine the structure of the cornea; and after a long maceration, in which it had greatly swelled, I observed a set of vessels totally distinct from the extremities of the minute blood-vessels. The minute blood-vessels which were injected, stopt abruptly on the margin of the cornea. But these I now mention are particular; they are in great profusion, large, and perfectly pellucid; they are large towards the middle of the cornea, and diminish towards the margin. Their free communication formed a net-work deep in in the thickened substance of the cornea. The size, perfect pellucidness, and intimate connection of these vessels, might perhaps incline one to call this a cellular structure.

* I have found the spark from iron, in blacksmiths and masons, buried in the cornea for several days (some authors say months), without exciting pain or much inconvenience. I have also more than once picked a little black slough from the cornea, mistaking it for a piece of iron, when it was only the consequence of the injury.

Mr.

Mr. Home * ſays, that an irritation on the edge of the cornea, and which includes the tunica conjunctiva, will produce greater inflammation, and more quickly, than a ſtronger excitement would produce on the centre of the cornea. This remark is probably from obſervation; but he adds, it is impoſſible that the veſſels of the cornea, which natually carry ſymph only, or ſerum, can be made to carry red blood, unleſs the irritation extends to ſome neighbouring part ſupplied with red blood. This, certainly, is an erroneous idea; for the little opacities which ſurround ſpiculæ ſticking in the cornea, the ulcerations on its ſurface, and little abſceſſes within its layers †, are the effect of inflammation of the part modified by its peculiar ſtructure; and theſe will all take place while the margin of the cornea remains clear, and there is no apparent connection of inflammation, or of veſſels with the conjunctiva.

Veſſels attach themſelves both to the inner and to the outer ſurface of the cornea; and when it becomes ſpongy and vaſcular in this way, little can be explained of its natural ſtructure. Thus, the pannus and pterygium are membranes which ſtretch acroſs and adhere to the cornea, while the iris frequently attaches to its inſide. In this caſe, the cornea becomes ſpongy, thick, and vaſcular; and, when cut, there is red blood in it ‡; and in ſtaphyloma §, the iris is generally attached to the cornea. I have a preparation in which the form and character of the iris is entirely loſt; it is extended into a reticulated membrane which lines the ſurface of the extended cornea.

* Philoſ. Tranſ. 1797, p.20.

† Viz. Onyx unguis, an abſceſs between the laminæ of the cornea, from a ſuppoſed reſemblance to the figure of a nail paired from the finger.

‡ Pterygium, is a diſeaſe of the conjunctiva, but which reſembles a membrane extended over the cornea from the canthus. Pannus, is a diſeaſe of the ſame kind, but covering the cornea as with a white opaque membrane.

§ Staphyloma, uvea, viz. a protruſion and opacity of the cornea; which, from the loſs of tranſparency and the general appearance of the tumor, is ſuppoſed to reſemble a grape.

OF

OF THE CHOROID COAT.

The choroid is the vaſcular tunic of the eye; it is ſo called from its reſemblance to one of the membranes of the ſecundines. It is the middle coat of the eye, lying betwixt the ſclerotic coat and retina. Injections ſhow it to conſiſt of two layers of cellular tiſſue; and it has upon its inner ſurface a pigment, which being ſometimes firm, might be taken for a membrane. It was Ruyſch who obſerved this diviſion of the choroid coat into two laminæ; and the inner one his ſon called the tunica Ruyſchiana: but of theſe hereafter.

Thoſe anatomiſts who ſuppoſed the ſclerotic coat to be the production of the dura mater, naturally concluded, that the choroid coat was derived from the pia mater; and as Ruyſch found it to be divible into two laminæ, ſo Sladius found the pia mater to conſiſt of two membranes. It followed, that the one lamina of the choroid coat was the continuation of the tunica arachnoides, and and the other of the pia mater; but this account of theſe membranes has no ſupport from obſervation. Betwixt the pia mater and choroid coat there is no reſemblance; the latter we ſhall find loaded with veſſels: but theſe veſſels are peculiar, and miniſter to a ſecreting ſurface. The pia mater in the brain, and optic nerve, is in ſtrict union with the ſubſtance of the brain, and ſupports and nouriſhes it; but the choroid coat has no connection with the retina or expanded nerve.

There can be no better mark of diſtinction between membranes than their degree of vaſcularity, and particularly in the manner of the diſtribution of their veſſels. The choroid coat is moſt particular in the diſtribution of its arteries and veins. The great arterial vaſcularity of the choroid coat is to be ſeen only after a very minute injection, and the venous vaſcularity after artificial or accidental infarction of the blood, or by a ſucceſsful injection from the ſuperior cava*; although the very great vaſcularity of this coat was known to our oldeſt

* An obſervation of Walter, certainly correct.

writers, yet the appearance of thefe veffels, when empty, has deceived many. Morgagni* and Maitre-jean have defcribed fibres which they affirm to be diftinct from the veffels, but which prove to be, in fact, the appearance prefented by the collapfed veffels.

The great peculiarity of the choroid coat, is its being a fecreting membrane; by which I mean, that the pigmentum nigrum which is applied to the medullary lamina of the retina being a fecretion, the choroid coat has neceffarily that peculiar ftructure of veffels which belongs to the fecreting membranes. This ftructure has enabled anatomifts to tear it into laminæ. For that part of the choroid coat next the fclerotic coat, is merely a vehicle of veffels and nerves, and is a tiffue of them connected by very fine cellular membranes. The internal part, again, is organized into a fecreting furface, and is the tunica Ruyfchiana†. I conceive, that the divifion into the choroid coat, and tunica Ruyfchiana, is warranted from the nature of the membrane, as the divifions of the coats of the inteftines are ‡.

Morgagni fays, that from his earlieft youth, he had many proofs that the choroid coat was not fingle in brutes; he afferts, alfo, that Francifcus Sylvius and Guenellonius had demonftrated the double laminæ of this membrane before Ruyfch §. Certain it is, that Ruyfch was not fo fortunate in afcribing a ufe to this tunica Ruyfchiana. He fuppofed that it gave ftrength to the choroid coat, and, by bringing a greater afflux of arterial blood, fupplied the neceffary heat to the otherwife cold humors ||.

Tapetum.—The internal furface of the choroid coat has been long called tapetum, from its villous or

* Morg. Epift. Anat. xvii. 2. † Ruyfch. Epift. Anat. xiii.

‡ Ablini Annot. Acad. lib. vii. cap. iv.

§ Morgagni Epift. Anat. xvii. 3.

|| Quod ad ufum tunicæ Ruyfchianæ attinet crediderim hanc tunicam inter ceteros ufus effe deftinatam, non folum ad robur choroideæ, verum etiam ut a fanguinis arteriofi majori copia requefitus calor tribus humoribus natura frigidis conciliaretur. Ruyf. Refponf. ad Chrift. Wedelium, p. 14.

fleecy

fleecy appearance, when ſeen through the microſcope. This ſurface in the adult is of a brown colour; in very young ſubjects it is red and bloody; and, when minutely injected, it is like ſcarlet cloth. It is by this vaſcular ſurface or tapetum that the black pigment, which is laid under the expanded retina in the human eye, is ſecreted.

The PIGMENTUM NIGRUM.—The pigmentum nigrum is the black or deep brown mucous ſubſtance which lies between the choroid coat and retina. It is of a nature to be waſhed away with a little water and a ſoft pencil*. This brown taint pervades the whole texture of the choroid coat. This matter is in immediate contact with the medullary pulp of the optic nerve. Its uſe is apparently to ſtifle the rays of light after they have impinged on the ſenſible ſurface of the retina; or we know that blackneſs is owing to the abſorption of the light, as whiteneſs and colour is the reflection of it from the ſurface of bodies. The dark colour of the ſecreted pigment of the choroid coat is, in ſome meaſure, peculiar to thoſe animals which ſee in the brighteſt light of day; but is wanting, or of a bright reflecting green or ſilvery whiteneſs, in ſuch as prowl by night. The natural concluſion, therefore, is, that the pigmentum nigrum ſubdues the intenſity of the impreſſion, while the reflecting colours of the ſurface in animals which ſee in the night, ſtrengthens the effect of the light on the ſurface of the retina, by repelling it. As fiſhes have the other proviſions for ſeeing in an obſcure light, they have alſo this of the reflecting

* I cannot conceive how this matter ſhould be confounded with the tapetum or tapis, which, as the name implies, is the villous ſurface of the choroid coat. Tapetum is, properly, cloth wrought with various colours; and the analogy was firſt uſed by the French Academicians, in their account of the diſſection of a lioneſs. "The membrane "which is put into the bottom of the eye, and laid on the choroides, "which we call the tapetum, was of an Iſabella colour, intermixed "with a greeniſh blue. It was eaſily ſeparable from the choroides, "which remained entire, with its ordinary thickneſs, after that "we had taken away the membrane which forms the tapetum." The explanation of this, I ſuppoſe, will be found in Morg. Epiſt. An. xvii. 3.

 ſurface

ſurface of the tapetum: as it is a ſecretion of the villous ſurface of the choroid, we ſee why it becomes ſomewhat deficient in old men, and ſometimes wanting in the degenerate varieties of animals; when entirely deficient, the blood circulating in the veſſels of the choroid coat gives a lurid redneſs to the reflections from the bottom of the eye *.

Finally, in regard to the choroid coat, we have to underſtand that it conſiſts of two laminæ: the outer, and that which is next to the ſclerotic coat, being the proper choroid; the internal lamina, the tunica Ruyſchiana: that on the ſurface of the tunica Ruyſchiana, there is a pile or fleece, which is called tapetum: and laſtly, that the ſecretion of this inner ſurface is a pigment, which, in the human eye, has the appropriate name of pigmentum nigrum; but, in many animals, it is of a ſilver, golden, or Iſabella colour; though in my apprehenſion, the colour, in all theſe varieties, depends ſtill upon a peculiar ſecreted matter.

OF THE CILIARY PROCESSES.

The ciliary proceſſes are formed of the anterior margin of the choroid coat; they give the appearance as if the choroid coat, at the anterior part, were folded inward to the margin of the chriſtalline lens; and, as if, to accommodate it to this ſudden inflection, it had been plated, and not regularly contracted; at leaſt, this is much the appearance of the circle of ciliary proceſſes, when, after cutting acroſs the eye, we look from behind upon the lens in its natural ſituation. In this view, we find the pigmentum nigrum of the choroid coat continued over the ciliary proceſſes, which gives to them the appearance of the regular plicæ of the choroid coat, converging to

* As the pigmentum nigrum is a ſecretion, we ſhall not be ſurprized to find it become deficient in the commencement of ſome diſeaſes of the eye. This is known by the poſſibility of ſeeing to the bottom of the eye; that is, the choroid coat becomes a reflecting ſurface, and throws out the beams like a cat's eye. See Med. Obſer. and Enquiries, vol. iii. p. 124.

the edge of the lens, and forming altogether a disk round it.

When the black paint on the ciliary processes is a little washed away, and when we attentively examine this part, we find the ciliary processes to be actually little oblong plicæ, which gradually arise from the choroid coat at the angle of its inflection, and terminate abruptly, approximating, but not attached, to the margin of the lens. When the paint is washed entirely away, the whole circle of these processes appears evidently to be the continued choroid coat.

When not injected, the ciliary processes are pale and loose; but when minutely injected, they take a perfect scarlet colour: they resemble, in their uninjected state, the valvular-like doublings of the vilous coat of the stomach and intestines. Before the choroid coat is inflected towards the lens, in the form of ciliary processes, it forms a firm adhesion to the sclerotic coat near the circular margin of the cornea, and at the same time is united firmly to the root of the iris. From this, the processes tend inward, and a little backwards; and are, at their external extremities, detached from the iris; nor are they attached to the margin of the lens, but are loose and floating.

When the vitreous humor and lens fall out from the anterior segment of the eye, we find that the plicæ or ciliary processes have left their impression on the anterior surface of the vitreous humor, and also on the intermediate expansion of the retina which extends before the membrane of the vitreous humor. This circular impression of the ciliary processes is called by Haller, striæ retinæ subjectæ ligamento ciliari *. I have called this impression HALO SIGNATUS, because it is formed of a circle of radiations, formed by the impression of the ciliary processes, and is not peculiar to the retina, but the retina again makes its impression on the membrane of the vitreous humor. The furrows and doublings of the anterior part of the retina, formed by the impression

* Fascie vii. icon. ocul.

of the ciliary proceſſes, Dr. Monro has called the ciliary proceſſes of the retina; but, for my part, I think this a term likely to confound and miſlead a ſtudent; and we might as well ſpeak of the ciliary proceſſes of the vitreous humor, or of the membrane of the vitreous humor, ſince they alſo take the impreſſion of the ciliary proceſſes *.

When the vitreous humor and lens are taken out of the coats, we ſee alſo that the ciliary proceſſes have left the ſtain of the fuliginous paint †. This it is neceſſary to remark, ſince I have ſeen ſtudents confound this mark with the ciliary proceſſes themſelves. The ciliary proceſſes are of a moſt elegant vaſcular ſtructure. Their contorted arteries are beautifully repreſented in Zinn's figure. He traces them from the extreme branches of the choroid coat; but, of their veins, he ſays nothing further than that they are continued from the branches of the vaſa vorticoſa, or veins of the choroid coat. The points of the ciliary proceſſes are not attached to the lens, but float looſe in the poſterior chamber of the aqueous humor ‡; but at a little diſtance from their points they adhere to the retina, where it is continued over the anterior part of the vitreous humor. Through this attachment only are they connected with the lens; for, as we ſhall find preſently, the retina (as a membrane, but not as the ſenſible retina) is continued over the chriſtalline lens §.

* Winſlow uſes the term ſulci ciliares, for the impreſſion on the vitreous humo Zinn calls this corona ciliaris, after Camper: he deſcribes them well, p. 75.

† See Morgagni Epiſt. Anat. xvii. n. 13. and Ruyſch alſo, "Nonnulli pro proceſſu ciliari agnoſcunt pullas pigmenti nigri reliquias, membranulæ tenuiſſimæ humoris chriſtallini & vitrei, & quaſi fibres mentientes, oculo ſc. aperto, humoribuſque exemptis; hæ autem nil ſunt niſi avulſæ particulæ pigmenti nigri." Ruſch. Theſ. An. ii. Aſſ. i. N° xv.

‡ This was demonſtrated in a particular manner by Ruyſch and Morgagni

§ Zinn and other later writers have entertained the idea, that the adheſion of the ciliary proceſſes to the membranes covering the vitreous humor is by a kind of gluing, rather than a union by cellular membrane. See Zinn, p. 75.

The

The ciliary proceſſes, collectively, form a circle round the lens, which I call corona ciliaris. This circle forming a perfectly opaque partition, which ſtifles all rays that might otherwiſe be tranſmitted by the ſide of the lens. The corona ciliaris, or ciliary circle, no doubt, ſerves at the ſame time as a connection between the outer and ſtrong coats of the eye and the tranſparent coats and humors; for, it is to be obſerved, that, excepting the connection which naturally exiſts between the optic nerve and retina, this ſlender hold which the ciliary proceſſes take of the expanded retina, is the only attachment betwixt the humors of the eye and the proper coats.

In regard to the names appropriated to this part of the eye, there is more confuſion than it is poſſible to believe. It is neceſſary to attend to this ambiguous uſe of terms, elſe we ſhall be in danger of miſunderſtanding our beſt authors. Veſalius conſiders the whole as a ſeptum betwixt the vitreous and poſterior chamber of the aqueous humor; but he ſeems to find much difficulty in giving it an appropriate name *. Fallopius and Morgagni † uſe the term CORPUS CILIARE for the whole circle of the proceſſes, and in the ſame ſenſe that I have ventured to uſe corona ciliaris. It is a name which conveys the idea neither of the ſhape nor of the ſubſtance of the thing meant. Ruyſch makes great confuſion by his uſe of terms; the corona ciliaris, or ciliary body, he calls the ligamentum ciliare; and the lines on the back ſurface of the iris, he calls proceſſus ciliaris muſculoſus; or rather, he means by this, the ſtraight fibres of the iris ‡. Du-

* "Neque mihi ullum occurrit nomen quod ipſi aptius indam "quam tunicæ: aut ſi voles, interſtitii vel ſepti inter vitreum hu-"morem & eum quem albugineum nuncubamus repoſiti." Veſal. vol. i. p. 558.

† Epiſt. Anat. xvii. 11.

‡ Ruyſch has this expreſſion: "Ligamentum ciliare neutiquam eſſe conſiderandum tanquam muſculum ad pupillæ et humoris criſtallini motum deſtinatum, totumque hoc negocium perfici a proceſſu ciliari ut et a circulo muſculari poſterius in confinio pupillæ ſito." Thes. Anat. ii. xv. See alſo the explanation of fig. iv. of this Theſaurus, where we have "Iris enim eſt facies exterior, proceſſus lig. ciliaris facies interior.

 verney,

verney, with Ruysch and Winslow, following Fallopius, calls the corona ciliaris also ligamentum ciliare. But the ciliary ligament is used by others in a widely different sense, viz. for the circular root of the ciliary body and iris, the anulum album cellulosum, or the frenula membranosa of Zinn. By Hovius, what I have called halo signatus, is called ligamentum ciliare. In Haller's fifth figure of the eye, this circular root of the ciliary processes is called orbiculus ciliaris. Maitre-jean, Haller, and others, call the whole body, or corona, the ciliary circle. M. Ferrein, Lanneau de la Choroide, and M. Lieutaud, denominated the ciliary processes "rayons ciliares," and the root of the corona ciliaris and iris, "plexus "ciliaris."

CHAP. III.

OF THE IRIS.

The iris is the coloured circle which surrounds the pupil, and which we see through the transparent cornea of the eye. It is a membrane hung before the christalline lens *. It is as if perforated in the middle; and this hole in the middle of the iris is the pupil; and through the pupil only can the rays be transmitted to the bottom of the eye. When we hear of the dilatation and contraction of the pupil, we have to understand the action of the iris, which, by possessing the power of con-

* Winslow and Haller, and most of the old anatomists, call this UVEA; by which they mean to imply that it is part of the choroides. See Ophthalmagraphia Authore G. Briggs, Cantab. 1676; but most of the modern anatomists follow Zinn and Lieutaud in calling it iris; though Lieutaud and others called the anterior surface only iris, while they still continued to call this perforated membrane choroides, or uvea. See Lieut. p. 117. Again, others call the posterior surface of the iris uvea, from its likeness to the dark colour of a raisin; and the word iris is borrowed, I suppose from the varied colours of the rainbow.

tracting

tracting and relaxing, holds a control over the quantity of light tranſmitted to the bottom of the eye. For by the extenſion of this membrane, the diameter of the pupil is diminiſhed, and by contraction of the membrane, it is dilated. This motion of the iris, and, conſequently, the ſize of the pupil, is connected with the ſenſation of of the retina; by which means, in diſeaſe of internal parts of the eye, it is often an index to us of the ſtate of the nerve, and of the poſſibility of giving relief by operation.

The iris and corona ciliaris, or ciliary proceſſes, are, in general, conſidered as being the two laminæ of the choroid coat continued forward and ſplit: the internal lamina of the choroid forming the corona ciliaris, and the outer one forming the iris. The former I was willing to conſider as the anterior margin of the choroid coat, becauſe it has no diſtinction in its ſtructure from that coat; but the iris I cannot conſider as the continued choroid coat; in the *firſt* place, becauſe I have found it fall out a perfect circle by maceration; *ſecondly*, becauſe it has no reſemblance in ſtructure to the choroid coat; and, *chiefly*, as by its power of contracting, it ſhows a widely different character from any of the other membranes of the eye.

The outer ſurface of this circular membrane gives the colour to the eye during life; and from its beautiful and variegated colours, it has gained to the whole membrane the name of iris. Haller and Zinn, nearly at the ſame time, explained the cauſe of this coloured iris, which had been, till then, ſuppoſed to be occaſioned by the refraction of the light amongſt its ſtriæ and fibres.

When this membrane is put in water, and examined with the microſcope, its anterior ſurface is ſeen to be covered with minute villi. The ſplendid colouring of the iris proceeds from the villi; but by beginning putrefaction, the ſplendid reflection fades, as the brilliant ſurface of the choroid of brutes is loſt by keeping. For this reaſon, I imagine the colour and brilliancy of the iris to depend on the ſecretion of theſe villi. But the colour of the iris depends, in a great meaſure, on the black

paint

paint upon its posterior surface shining through it; and the black and hazel-coloured iris is owing to the greater degree of transparency of the iris, which allows the dark uvea to shine through it.

The iris is acknowledged to be the most acutely sensible part in the body. We have, then, to expect in its composition, muscular fibres, and to account for its acute irritability and sympathy, by a profusion of nerves: again, as the power of the muscular fibre, and the sensibility of the nerve, are both, in some measure, indebted to the circulation of the blood, we may expect to find also a profusion of vessels in the iris. In all these respects we shall find the iris to be an object of admiration.

OF THE MUSCULAR FIBRES OF THE IRIS.

It is evident from a note, under the head corona ciliaris, that Ruysch had observed two sets of muscular fibres in the iris; for, under the name of ciliary ligament, he describes a set of radiated fibres which go from the ciliary processes towards the circular margin of the pupil: he observed also, the circular or orbicular fibres which run round the margin of the pupil. Winslow says, that between the two laminæ of the uvea (viz. iris) we find two thin planes of fibres, which appear to be fleshy: the fibres of one plane orbicular, and lying round the circumference of the pupil, and those of the other being radiated; one extremity of it being fixed to the orbicular plane, the other to the great edge of the uvea. Zinn describes, with much minuteness, radiated fibres (on the anterior surface of the iris), but does not consider these as muscular fibres; and he confesses, that he could not observe the orbicular muscle which Maitre-jean and Ruysch had painted. Even in owls and other creatures having a strong iris, he could not discover an orbicular muscle; nor were Haller and Morgagni more succesful in this investigation *. Wrisberg also affirms,

* See Zinn, p. 89 and 90. Morgagni Epist. Anat. xvii. § 4. Haller and Ferrein attribute the motion of the iris to an afflux of humors in its vessels.

that

that no mufcular fibres could be feen in the iris of the ox. Dr. Monro, on the other hand, adheres to the opinion of the mufcularity of the iris: he defcribes minutely both the radiated and fphincter fibres. Wrifberg and others have thought they found fufficient proof againft the mufcularity of the iris, in the fact of its not contracting when the light falls upon its furface. To this Dr. Monro anfwers, that the colour or paint upon the iris muft, like a cuticle, prevent the light from irritating the iris. I cannot think that this circumftance fhould prevent the excitement of the iris. The retina is in a peculiar manner fufceptible of the impreffion of light; but we cannot wonder that light fhould not ftimulate a mufcle to contraction, when we have every proof that it has no effect on the moft delicate expanded nerve of the other fenfes.

That the iris is to be affected only through the fenfation of the retina, or perhaps rather the effect communicated to the fenforium, we have fufficient proof. I have, in couching, repeatedly rubbed the fide of the needle againft the iris without exciting any motion in it: I have feen it pricked flightly by the needle without its fhowing any fign of being irritated; nay, what was too a convincing proof, I have feen it cut by falling before the knife in extracting the cataract. In this laft inftance, far from being ftimulated to contraction, it hung relaxed *.

It is evident, then, that no common ftimulus, immediately applied to the iris, has any fenfible effect in exciting it to contraction; and that it is fubject only, in a fecondary way, to the degree of intenfity of light admitted to the retina. The movement of the iris is in general involuntary; but terror and fudden fright affect

* This fact deftroys the hypothefis of M. Mery, of the Royal Acad. of Sciences, that the ftraight fibres of the iris are little cavernous bodies, and that the action of the light upon the retina fwelled and elongated them fo as to caufe the diminution of the fize of the pupil: for by this cut, they muft have fallen from their erected ftate, and contracted fo as to have dilated the pupil. See Acad. Roy. de Sc. 1704, mem. p. 261.

it.

it. In ſome animals, particularly in the parrot, it is a voluntary muſcle *. As an object, upon which we look, approaches the eye, the pupil contracts, which is an effect of the increaſing intenſity of the light reflected from the object; for, as the object advances, it fills a greater ſpace in the ſphere of viſion, and of courſe more rays flow from it into the eye.

NERVES OF THE IRIS.—The iris is ſupplied with nerves in great profuſion. They are derived from the long ciliary nerves which run forward betwixt the cornea and choroid coat towards the common root of the corona ciliaris and the iris. They there divide, and are ſeen to paſs in numerous branches into the ſubſtance of the iris. In the ſubſtance of the iris, the branches of the nerves, from their extreme minuteneſs, are ſoon loſt amongſt its pale fibres.

BLOOD VESSELS OF THE IRIS.—I have had preparations which ſhowed ſo great a degree of vaſcularity in the iris, that I was ready to believe its action to be produced entirely by a vaſcular ſtructure; but when, on other occaſions, my admiration was excited by the profuſion of nerves, and I was led to obſerve that in the former inſtances they had been obſcured by the injection, I could not but allow that the muſcular fibres might have been obſcured as the nerves were.

T ere are four arteries ſent to the iris: two long ciliary arteries which take a long courſe on the outſide of the choroid coat, and two leſſer and anterior arteries which pierce the ligamentum ciliare from without. Theſe arteries approach the root of the iris at four oppoſite points, and branching widely form a vaſcular circle round the root of the iris, viz. the larger circle of the iris. From this circle branches paſs off, which run with a ſerpentine courſe, converging to the edge of the iris: here

* When a cat is rouſed to attention, as by the ſcratching of a mouſe, it dilates the pupil, which allows a ſtronger impreſſion on the bottom of the eye; nay, whenever puſs ſtruggles violently to get looſe, the pupil dilates, which may ſufficiently account for M. Mery's cat having her pupil dilated when he plunged her under the water. See Acad. Roy. des Sc. 1704, mem. 261.

they

they again throw out inofculating branches, which form a circle furrounding the pupil, but at fome little diftance from the edge of the iris—this is the leffer circle of the iris. From this leffer circle there again proceed minute branches towards the edge of the iris *.

The VEINS, which intermingle their branches with thefe arteries, pafs fome of them into the vafa vorticofa of the choroid coat, and others take a long courfe betwixt the choroid and fclerotic coat, accompanying the ciliary nerves, whilft fome branches pierce the fclerotic coat at the root of the iris, and become fuperficial upon the fore part of the eye.

CHAP. IV.

PRACTICAL REMARKS DEDUCED FROM THE STRUCTURE OF THE CHOROID COAT AND IRIS.

THE choroid coat, ciliary proceffes, and iris, being the moft vafcular parts of the eye, are frequently the feat of difeafe, and adminifter to the diforder in all violent internal affections of the organ. I had always conceived thefe parts to be chiefly active in the carcinoma of the bulb of the eye, and I had lately an opportunity of obferving this in diffection. In this difeafe, there is firft deep pain in the eye, from the inflammation and diforder of the vafcular coats; and often the effect of the increafed action within the eye is known from its effects in enlarging the veins on the furface of the eyeball. Thefe veffels being active in their natural ftate, are very apt to become difeafed when difturbed in their action; and although we frequently fee the eye quite funk, yet, when it is burft, and the vafcular coats are protuberant, a cancerous ftate of the eye is to be dreaded.

* See Ruyfch. Epift. Anat. Prob. xiii. p. 31.

When

When the eye is hurt by a blow; when inflammation ſpreads from the cornea to the iris, in conſequence of a ſmall-pox puſtule; when an ulcer of the cornea, or an inciſion of it does not heal quickly, but allows the aqueous humor to diſtil out, and conſequently the iris to fall in contact with the cornea; the iris adheres, and often forms ſtaphyloma. Thus we find ſtaphyloma to follow the operation of extraction, in conſequence of the iris protruding and adhering to the wound: again, in ſtaphyloma from ſmall-pox by the adheſion of the iris to the cornea, while the cornea is extending and perhaps burſts, the iris mixes with the cornea, and gives the ugly black and mixed colours of this diſeaſe. I have a preparation in which the cornea had greatly dilated; the iris is extended like a black net-work upon the inner ſurface of the cornea; and in the uſual place of the iris, the ciliary proceſſes are to be ſeen. The iris adheres alſo to the capſule of the lens, which is behind it, and, as we ſhall preſently ſee, cloſe upon it. I ſaw it in one inſtance adhering ſo ſtrongly to the cataract, that, in attempting to depreſs the cataract with the needle, the edge of the iris was turned over and depreſſed with the needle, and the regularity of the pupil was deſtroyed; of courſe, here there could be no permanent depreſſion, without previouſly cutting this adheſion.

It was at one time believed, on the authority of many excellent anatomiſts, that the veſſels of the iris were colourleſs, and did not circulate red blood: after what has been ſaid, it is ſcarcely neceſſary to mention the fallacy of this opinion *. I have ſeen the iris cut and bleeding, though not profuſely as I expected; the ſmall quantity of blood ſoon coagulated into a dark ſpeck, while I expected it ſhould have been effuſed in the aqueous humor.

* Dr. Monro, in treating of this ſubject, mentions his having ſeen a net-work of veſſels covered with paint darker than that of the iris, and extended from the iris upon the ſurface of the lens; and, in another inſtance, a net-work of filaments paſſing quite acroſs the pupil. See his Diſſertations, p. 108.

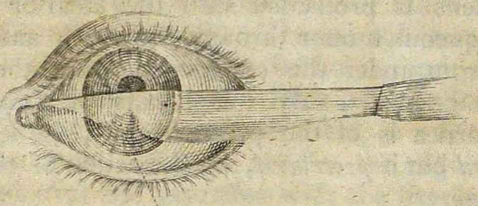
There

There is a circumſtance in the operation of extracting the cataract which I have ſeen little attended to, and yet it is ſufficiently evident. When the cornea has been cut, operators, diſappointed in not finding the cataract protruded, keep the eye ſtaring in the light, and preſs the ball of the eye; but while the eye is thus expoſed to the excitement of the light, the pupil is contracted, and the lens propelled by the action of the muſcles; and, ſtill more, by the preſſure made on the eye-ball, is in danger of preſſing through and tearing the iris. The beſt operators have been in the cuſtom of ſhutting the eye-lids the inſtant the inciſion was made in the cornea; by this means, the eye is for a time ſupported in ſome degree during the violent ſpaſm of the recti muſcles, and the iris being allowed to dilate, the lens is protruded into the anterior chamber of the aqueous humor through the pupil, and is ready to ſlip from under the cut cornea, when the eye-lids are again opened. By this means, if the inciſion of the cornea is of the proper extent, the lens is not *extracted* but is *protruded*, by the action of the muſcles of the eye.

It is very neceſſary for us to remember, that all the parts of the eye, in themſelves extremely delicate, are kept in their relative places, not by adheſions, but by the complete ſupport they derive from the globular form of the eye, and by the ſtrength of the outer coat or ſclerotic and cornea. To this, it is particularly neceſſary to attend, in the operation of the extraction of the cataract; for, as ſoon as the aqueous humor is evacuated, the uniform reſiſtance of the coats of the eye is deſtroyed, and the muſcles ſurrounding the eye-ball force all the humors towards the inciſion. It is this circumſtance which brings the iris into great danger of being cut when the knife is too narrow to make the inciſion, at once, by puſhing it through the cornea with an uninterrupted motion of the fingers. For, when the knife is not broad enough to cut itſelf out by moving it uniformly along, the aqueous humor eſcapes in the endeavour to cut downwards, and the iris is protruded

ſo as to fall under the edge of the knife; nay, with a good knife, and of a ſhape to cut itſelf out, and at the ſame time adapted to make a cut in the cornea ſufficient to allow the eſcape of the lens, I have ſeen, in conſequence of a heſitating manner of introducing the knife, the aqueous humor ſuffered to eſcape. Now, obſerve the conſequence of this: — The lens being puſhed outwards by the contraction of the muſcles on the eye-ball, towards that point at which the continuity and conſequent uniform reſiſtance of the coats were broken, the margin of the iris was forced under the edge of the knife and cut, as I have here repreſented.

Fig. 12.



The margin of the Iris fallen before the edge of the knife & cut

A very particular effect of this cut upon the margin of the iris is to be obſerved. — When the inciſion has been happily done, the lens is protruded uniformly through the pupil; but when the iris was cut, as now explained, the edge of the lens oppoſite to the part of the iris which was cut, was forced forward; the lens was turned ſide-ways, without being entirely diſplaced; and a great part of the vitreous humor was allowed to eſcape *.

* See further, Operative Surgery by C. Bell.

CHAP.

CHAP. V.

OF THE RETINA, AND DIGRESSION CONCERNING THE SEAT OF VISION.

THE term retina has, in a modern publication, been objected to, as improperly applied to the inner coat of the eye. Such a term, it has been said, may well be applied to the nerve expanded on the lamina spiralis of the cochlea, because it is there formed into an intricate plexus by innumerable joinings and separations of its component parts; but used for the expanded nerve of the eye, the term retina is thought improper *. We must look for the resemblance, however, which justifies this term, not in the medullary matter of the nerve, but in its vessels. "Hanc figuram egregie repræsentat dicta "tunica retina cum arteriolæ ceracea materia sunt "repletæ †."

The retina is the expansion of the optic nerve; the immediate seat of sensation, and the most internal of those membranes which are called the coats of the eye. It has been already observed, that there is a distinction betwixt a nerve in its course from the brain to the organ of sense, and where it is actually expanded and adapted to the reception of the external impression. Before the optic nerve has perforated the sclerotic coat of the eye, it is surrounded with a firm sheath; and its substance is evidently composed of bundles of fibres, though not so coarse, yet like those of the nerves in the other parts of the body. The opacity of the nerve makes it have little the appearance of vascularity, but when the body of the nerve is made transparent, it becomes like a red cord; so necessary is it that the medullary substance of the nerve be supplied with blood.

* Dr. Monro's 4to. Treatises.

† Ruysch. Epist. Anat. xiii. p. 14. Quamobrem servare adhuc retinæ, appellationem si non ex fibrarum ut cert ee xvasorum implicatione, &c. Morgagni Epist. Anat. xvii. § 43.

 The

The ſtronger ſheath which ſurrounds the body of the optic nerve is looſe, and may be ſeparated into lamellæ. There is a more delicate membrane which immediately adheres to the ſurface of the nerve; and its ſubſtance is formed into the minute faſciculi which give it the fibrous appearance by a ſtill firmer intertexture of membrane. This interwoven membrane proceeds, with the retina, into the eye; the other ſheaths are reflected off, and unite with the ſclerotic coat. Some little way from the back part of the eye, the arteria centralis retinæ pierces the ſheath of the nerve, plunges into the centre, and paſſes into the eye along with it. If the optic nerve be cut near to the eye, the open mouth of this ſmall artery may be ſeen; but if we make our ſection ſome way removed from the back of the eye, it will, of courſe, not be ſeen. The ſpace left by the artery contracting in the centre of the nerve when thus cut, (or perhaps it was the open mouth of the artery itſelf,) was obſerved by the ancients, and by them called the porus opticus; they were ignorant of this central artery of the retina *.

Where the optic nerve is about to enter into the ball of the eye, it is much diminiſhed in diameter; it is contracted and condenſed, and, at the ſame time lays aſide the ſtrong coats. The proper nerve then perforates a cribriform lamina in the ſclerotic coat. Within the eye, the filaments ſeen in thenerve are no longer diſtinguiſhable; but from the extremity of the nerve the fine web of the retina is produced.

The LAMINA CRIBROSA, and the delicate faſciculi of the optic nerve, are ſhewn in this manner: after making a ſection of the eye, waſh away the retina from the extremity of the optic nerve, and alſo the choroid coat; then preſs the optic nerve betwixt the finger and thumb, when the pulp of the nerve will be ſeen to protrude through the foramina in the ſclerotic coat like white

* Porum opticum Herophilus et omnis ab ea antiquitas dixit, foramen nempe quod in diſſecto nervo de vacua arteria ſupereſt. Hall. Arter. Ocul. Hiſt. p. 42. De Vaſis Nervi Optici vide Ruyſch. Epiſt. Anat. xiii. tab. xvi. Albinus Acad. Anat. lib. vii. c. vii.

7 points.

points. It is obferved by Zinn, that, in doing this, there is a central foramen which remains unfilled up by the compreffion of the nerve. This is the hole perforated by the arteria centralis retinæ *. Where the threads of nerves are accumulated after paffing thefe foramina, and before they are finally expanded into the retina, they neceffarily form a fmall cone or papilla. This conical form of the extremity of the optic nerve is much more evident in fome animals than in others; but in a fection of the human optic nerve we may alfo obferve it †.

The retina is a membrane of the moft delicate texture of any in the animal body: it is tranfparent in the recent ftate, and fo foft, that it will tear with its own weight. In fpirits and weak acids, it becomes opaque and firmer. It lies expanded over the vitreous humor, and contiguous, but not adhering, to the choroid coat, or its pigment. The retina does not confift merely of the expanded nervous matter, but has, in its compofition, a very fine membrane, and many minute veffels. When the retina is macerated for a confiderable time, the pulp of the nerve can be wafhed away, and there remains only the reticulated and delicate membrane which fupports the veffels that nourifh it. But though the pulp of the nerve may be diffolved, it cannot, by diffection, be freed from the membrane which fupports it ‡.

* Zinn de oculo humano, p. 106. Com. Reg. Soc. Scient. Gotting. loc. cit. About 30 foramina have been obferved in the lamina cribrofa. See Haller Fafc. de Arter. Oculi, p. 42.

† Zinn. "At the place which anfwers to the infertion of the "optic nerve, we obferve a fmall depreffion, in which lies a fort of "medullary button terminating in a point." Winflow, p.78.

‡ "Poffe vere medullarem retinæ laminam removeri ut vafculofum rete membranæ figuram retineat, alteramque ab altera integram detrahi ultra hominum artem pofitum effe videtur nec ulli unquam contigiffe legere me memini, etfi, deleta macerendo medulla, rete vafculofum laminam peculiarem referre videatur. Ex quibus omnibus elicio retinam effe tunicam fimplicem, ex cellulofa conflatam: que vafcula et fubftantiam medullarem fuftinet etfi duas diverfas oftendat facies alteram vafculofam interiorem, alteram medullarem exteriorem." Zinn, p. 112.

I have a preparation which more reſembles ſome of Ruyſch's plates than any I have ſeen. In this preparation, the nerve being waſhed away, we may ſee diſtinctly the whole courſe of the arteria centralis retinæ. Of this preparation I have given an engraving, to ſhow how plentifully this organ is ſupplied with red blood; from which circumſtance we may learn the ſtrict dependence of its function on the circulation, and deduce the derangement of the powers of viſion, as a natural conſequence of the diſordered action of theſe veſſels.

The ſoft medullary matter of the retina is towards the ſurface of the choroid coat, and forms there a lamina, which appears to me to be the ſurface of the nerve upon which the rays of light impinge *. The veſſels of the retina run upon the ſurface contiguous to the vitreous humor †. The arteria centralis retinæ is derived from the ophthalmic artery. It pierces the optic nerve, as we have already obſerved, and enters the eye through the porus opticus, to ſupply the retina. But the arteries of the retina do not always enter into the eye in one trunk; on the contrary, ſometimes two or three branches pierce the lamina cribroſa ‡, and afterwards, two, three, or four principal branches, ſpread out on the circumference of the retina; from theſe, the ramifications are ſo numerous, that Ruyſch deſcribes them as

* "C'eſt ſur-tout dans les poiſſons qu'il eſt facile de diſtinguer et "meme de ſeparer ces deux lames." Cuvier, tom. ii. p. 419.

The opacity of the outer ſurface of the retina prevents the vaſcularity from being apparent. Albinus, after a very minute injection, obſerved, that when he lifted up the choroid coat, the vaſcularity of the retina was not ſeen: "Autem de ea aliquid acuto ſcalpello ſub- "tiliter leviſſimeque deradens, mox conſpicio vaſa impleta multa quæ "ſub medulla cujus nimirum portionem deraſeram latuerant." Albin. An. Acad. lib. iii. cap. xiv.

† Dr. Monro has theſe words, expreſſive of an oppoſite opinion: "The whole appears to be compoſed of an uniform pulpy matter, on the outer ſide of which chiefly veſſels are diſperſed, ſupported, I ſuppoſe, by a membrane the ſame or analagous to the pia mater." 4to Treatiſes on the eye, ear, &c.

‡ Haller loc. cit. Morgagni. Ep. Anat. xvii. n. 44. nor do they always pierce the centre of the nerve exactly. Morgagni.

con-

conſtituting the membrane *. Correſponding with the arteria centralis retinæ in the adult, there are veins, the minute extremities of which, after forming connections with the veins of the corona ciliaris, run backwards on the inner ſurface of the retina in three or four diſtinct branches. Theſe uniting into a trunk, perforate the lamina cribroſa, and become the ſocia arteriæ centralis.

Many have been led to believe, that the retina terminates forward on the roots of the ciliary proceſſes, as others have conceived it to be continued over the fore part of the vitreous humor, and over the ſurface of the lens †; but the moſt prevalent opinion is, that it terminates on the margin of the lens.

That the retina extends over the back of the lens, and receives there the impreſſion of light, is very improbable; but that the membrane which ſupports the retina, is continued over the lens, is demonſtrable. As I have juſt ſaid, the retina I conceive (with Albinus, M. Ferrein, and others) to conſiſt of two diſtinct parts, viz. the medulla of the nerve, and a pellucid membrane ſupporting it; but, however reaſonable this concluſion is, I cannot believe that theſe portions are to be ſeparated by diſſection. It is by moſt anatomiſts believed, that the retina paſſes forward betwixt the vitreous humor and ciliary body, and adheres to the margin of the lens. Now, as this adheſion is not a gluing together of parts, but a union or intermixture of membranous filaments, the interchange and mingling of fibres, we may ſafely ſay, that the membrane of the retina is continued over

* "Iteratis perſcrutiniis reperio oculis armatis arteriolarum extrema tam eſſe numeroſa & tam arcte ſibi invicem et intricate annexa ut peculiarem repreſentent membranulam ex arteriolarum extremis conſtitutam, cui connectetur dicta medulloſa ſubſtantia." Ruyſch Epiſt. Anat. xiii. p. 15.

† Many anatomiſts, Winſlow, Caſſobohm, Ferrein, Lieutaud, and Haller, have taught that the retina extends over the great convexity of the lens, or that it is inſerted into it. Galen believed it to extend over the lens. For an impartial hiſtory of opinions, ſee Morgagni Epiſt. Anat. xvii. 47. and Zinn, 114.

the lens, and forms part of its capſule. The opacity of the retina is diminiſhed at the root of the ciliary proceſſes, and diſappears altogether at the margin of the lens; and here it is not only changed by becoming perfectly tranſparent and allied to the membranes of the humors, but it becomes alſo diſtinguiſhable from the opaque retina by a greater toughneſs and ſtrength. The continuity of the retina with the capſule of the lens is more apparent, when both membranes have become opaque by being immerſed in ſpirits or vinegar, but more particularly when that opacity is produced by diſeaſe. In diſeaſe, I have found the veins of the retina running over the margin of the lens, and branching on its poſterior convexity.

Where the retina lies betwixt the vitreous humor and the ciliary proceſſes, it is plaited, and deſcends into the interſtices of theſe proceſſes.

When we take off the ſclerotic and choroid coats of the eye, by diſſecting them round the inſertion of the optic nerve, and fold them back, carefully preſerving the retina; and when we have taken away the ciliary proceſſes from their adheſion to the fore part of the retina, we find the retina to form a ſac ſurrounding the vitreous humor, and ſupporting the lens. In all this ſurface, the membrane is ſmooth and uninterrupted. To the margin of the lens all this ſac is opaque; becauſe, upon the outſide of the retina, is the opaque pulpy nervous matter, but the coats of the lens are tranſparent, yet continuous with the arachnoid portion of the retina. When theſe parts of the eye are thus diſſected, they hang all together by the optic nerve; viz. the lens, the vitreous humor, and the expanded matter of the nerve being ſupported by delicate and pellucid membranes, conſtituting part of the retina; and the organ is diveſted only of its outer apparatus; we ſtill retain within this the more eſſential and important parts.

THERE

There is here a natural division; and I am willing to pause upon this, knowing well with how much difficulty the student gains a knowledge of the minute structure of the eye. All within the connections of the retina I shall call the INTERNAL GLOBE of the eye, as distinguishing it from the outward coats of the eye and parts subservient to them. A view of the little vascular system of these internal parts, thus classed, will show how strictly they are connected together, and how much insulated from the other parts.

But this is a subject upon which we cannot venture, until we have considered the nature and relative situation of the humors of the eye.

DIGRESSION ON THE SEAT OF VISION.

M. L'Abbé Marriotte discovered the curious fact, that when the rays fall upon the centre of the optic nerve, they give no sensation. He describes his experiment in this manner: — "Having often observed, in dissections of men as well as of brutes, that the optic nerve does never answer just to the middle of the bottom of the eye; that is, to the place where the picture of the object we look directly upon is made; and that, in man, it is somewhat higher, and on the side towards the nose; to make, therefore, the rays of an object to fall upon the optic nerve of my eye, and to find the consequence thereof I made this experiment. I fastened on an obscure wall, about the height of my eye, a small round paper, to serve me for a fixed point of vision; I fastened such another on the side thereof towards my right hand, at the distance of about two feet, but somewhat lower than the first, to the end that I might strike the optic nerve of my right eye while I kept my left shut. Then I placed myself over against the first paper, and drew back by little and little, keeping my right eye fixed and very

 steady

ſteady upon the ſame, and being about ten feet diſtant, the ſecond paper totally diſappeared *."

This defect in the viſion of the one eye is corrected by that of the other; for the inſertion of the optic nerves being towards the ſide next the noſe, no part of an image can ever fall on the optic nerve of both eyes at once; the defect of viſion, therefore, is obſerved only in very careful experiments. Experiments were, however, made by M. Picard, Marriotte, and Le Cat, to render this effect produced by the image falling on the centre of the optic nerve evident, when looking with both eyes. Marriotte's ſecond experiment was this: Place two round pieces of paper at the height of your eyes, three feet from one another, then place yourſelf oppoſite to them at the diſtance of 12 or 13 feet, and hold your thumb before your eyes at the diſtance of about eight inches, ſo that it may conceal from the right eye the paper that is to the left hand, and from the left eye the paper to the right hand. If now, you look at your thumb ſteadily with both eyes, you will loſe ſight of both the papers †. The novelty of ſuch a diſcovery was likely, as frequently is the caſe, to carry men's minds beyond the true point. It requires time for ſuch facts to deſcend to their level, in the ſcale of importance, with other leſs novel obſervations. Marriotte, upon this fact, formed a new hypotheſis relating to the ſeat of viſion. We have obſerved, that the choroid coat and pigmentum nigrum are deficient, where the optic nerve enters the eye, and is about to expand into the retina. He fixed upon the moſt unaccountable ſuppoſition, that the retina does not receive the impreſſion of the rays but that the

* Vide Phil. Tranſ. No 35. Smith's Optics, Remarks on art. 87.

† Dr. Smith made the ſtream of light through the key-hole of a dark chamber fall upon this point of the retina, oppoſite to the termination of the optic nerve, but he found it quite inſenſible even to this degree of light. M. Picquet aſſerts, that very luminous objects make a faint impreſſion on the centre of the optic nerve. But Dr. Prieſtley ſays, that a candle makes no impreſſion on that part of his eye.

choroid

choroid coat is the feat of the fenfe. In fupport of this theory, he foon found other arguments than thofe arifing from the deficiency of the choroid coat at the entrance of the nerve. He faw that the pupil dilated in the fhade, and contracted in a more intenfe light: now, fays he, as the iris is a continuation of the choroid coat, this is a proof of the great fenfibility of that coat: again, the dark colour of the choroid coat he fuppofed to be well calculated for the action of the rays of light, which are not reflected from it or tranfmitted, but abforbed; while, on the other hand, the retina is tranfparent. If vifion were performed in the retina, fays Marriotte, it feems that it fhould be found where-ever the retina is; and fince the retina covers the whole nerve as well as the reft of the bottom of the eye, there appears no reafon why there fhould be no vifion in the place of the optic nerve. M. Picquet argued in oppofition to Marriotte. He obferved in regard to the fitnefs of the black colour of the choroides for the action of the rays of light, that the choroid is not univerfally black; that there are many fhades of difference in the human eye; and that it is black, blue, green, yellow, or of a metallic fhining furface, in a variety of animals. He conceived, that the defect of vifion at the infertion of the nerve is occafioned by the blood-veffels of the retina*. He obferved, alfo, that the opacity of the retina is fuch, as neceffarily to obftruct the tranfmiffion of the rays of light to the choroid coat. M. de la Hire took part in this controverfy. He confidered the retina as the organ of fight, although a particular point of it is not fufceptible of immediate impreffions from outward objects; for, fays he, we muft not conceive fenfation to be conveyed by any other means than by the nerves. But, obferving the conftitution of the other organ of the fenfes, he entertained an idea that

* Againft this hypothefis, the fize of the infenfible fpot was urged by Marriotte. Bernuoilli calculated that this fpot is a circle, the diameter of which is a feventh part of the diameter of the eye, and that the centre is 27 parts of its diameter from the point oppofite to the pupil and a little above the middle.

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the retina receives the impreſſion in a ſecondary way, and through the choroides, as an intermediate organ; that, by the light ſtriking the choroid coat, it is agitated, and communicates the motion to the retina; and we find that, through all the organs of the ſenſes, he continues, the nerves are too delicate to be immediately expoſed to the naked impreſſions of external bodies.

Another objection to the opinion, that the retina is the ſeat of ſenſation, has been lately urged, viz. that the thickneſs of this coat, together with its tranſparency, allows of no particular ſurface for receiving the image; and that its tranſparency would cauſe a partial diſperſion, which would produce a confuſion in viſion *.

If theſe opinions require ſerious refutation, we have it in the effects of the diſeaſes of the retina, optic nerve, and brain. But the thalami nervorum, the optic nerve, and its expanſion into the retina, ſeem ſcarcely to have ever occurred to theſe ſpeculators, as worthy of notice in this inveſtigation.

The following appears to me the true account of this matter. It is demonſtrated, that the inner ſurface of the retina is a web of membrane conveying veſſels, and that the outer ſurface of the retina conſiſts of the pulpy-like nervous matter. This latter, then, is the organized ſurface adapted to receive the impreſſion of the rays of light. At the point where the optic nerve comes through the coats of the eye, there is no poſterior ſurface peculiarly adapted to receive the impreſſion of light; and, as well might we expect the optic nerve to be ſenſible to the impreſſion of light in any point of its extent from the brain to the eye, as at this; for here the inner ſurface of the retina only is formed; there is no poſterior ſurface upon which the rays can impinge. The doubts regarding the cauſe of this ſpot giving no ſenſation, have ariſen

* M. Le Cat thought the pia mater was the ſentient part of the nerve. It was, therefore, a kind of confirmation of his opinion to ſuppoſe the choroid to be the ſeat of viſion, as he teaches that the choroid coat is a production of the pia mater. He conceived that the retina moderated the impreſſion of light upon the choroid coat, as the cuticle dulls the impreſſion on the papillæ of the tongue.

from

from the idea, that the internal ſurface of the retina, or its ſubſtance, felt the impreſſion of the rays of light.

At the ſame time, it is evident, that the choroid coat, and its ſecretion is in a moſt remarkable manner ſubſervient to the retina, as the inſtrument of viſion: for, when the ſecretion is black it abſorbs the rays; and animals which have ſuch a pigmentum nigrum, ſee beſt during the full day: again, when the ſurface is of a ſhining nature, it repels the rays, and this contributes to ſtrengthen the ſenſation; and ſuch animals are fitted for ſeeing in obſcure light: nay, further, if the ſurface of the choroid be coloured, the animal will ſee objects of that colour the beſt, becauſe the colour of the choroid depends upon its reflecting more of the coloured ray, than of the others of which light is compoſed.

But as animals ſee which have no paint on the choroid, neither ſuch as will abſorb, nor ſuch as will ſtrongly reflect the rays, and which have merely the ſurface of the choroid with its coloured blood-veſſels in contact with the retina; ſo, it is evident, that it is not the deficiency of the choroid coat, nor the want of the black paint at the entrance of the optic nerve, which prevents the ſenſation, but really, that there is here no ſurface formed and organized to receive the impreſſion of the light; the internal ſurface not being the ſenſible ſurface of the retina.

FURTHER OBSERVATIONS ON THE RETINA.

It has already been obſerved, that viſion is the combined operation of the external organ, nerve, and brain; conſequently, the deſtruction of the function may be produced by diſeaſe of the retina, of the optic nerve, or of the brain. Any partial injury, preſſure, electricity, or galvaniſm, influencing the retina, will cauſe the ſenſation of light or fire before the eye *. Becauſe here or

* Light from preſſure on the eye. See Carteſius, cap. ix. lib. de Meteor, and the ophthalmo-graphia of Brigg's, *cornea,*

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in its correſponding part of the brain, is the organ of viſion; and no idea but of light is this organ capable of exciting in the mind. Diſeaſe in the retina, nerve, or correſponding part of the brain, cauſing total blindneſs, while the cornea and humors of the eye remain pellucid, is called AMAUROSIS. It is, in general, to be conſidered as a paralytic affection. Amauroſis * has been found to follow ſtrokes on the head; concuſſion and compreſſion of the brain; blood effuſed within the ſkull; or tumors preſſing on the nerve or brain †. An amauroſis ſpaſmodica has been enumerated by authors. This kind of blindneſs has been ſuppoſed to ariſe in conſequence of the ſtricture of the optic nerve by the origins of the recti muſcles; as far as I have obſerved, no action of theſe muſcles can affect the optic nerve before it perforates the coats of the eye. If it were to be attributed to the operation of theſe muſcles, I ſhould rather ſuppoſe it to be occaſioned by their ſpaſmodic action on the ball of the eye, by which the function of the retina may be diſordered; but I think it is more probable that the ſame irritation which is acting on the motatory nerves of the eye, does in this inſtance, affect alſo the optic nerve and retina. However, diſtention of the coats of the eye, by encreaſed ſecretion of the humors, deſtroys the ſenſibility of the retina. In the hydrophthalmia, there is in the beginning a ſhort-ſight-

* AMAUROSIS; GUTTA SERENA; CATARACTA NIGRA; which laſt name is from the blackneſs of the pupil in conſequence of the tranſparency of the lens.

† "Ipſe vidi bis in puerulis ſcrophuloſis amauroſin, etiam ſubito ingruentem; ſecto cadavere inveni glandulam ſtrumoſam nervis opticis incumbentem." *Sauvages Noſol.* From many obſervations, we find that tumors and extravaſations, which muſt compreſs gradually, do yet produce an inſtantaneous effect.

In Bonetus ‡, we have many caſes of blindneſs from abſceſs in the anterior part of the brain; from fluid on the ſurface, and in the ventricles; from ſteatomatous tumors; from coagulum of blood, and from a hydatid preſſing on the union of the optic nerves; and, laſtly, from a calculus in the optic nerve. Blindneſs from preſſure upon the eye and its diſplacement, and conſequent elongation of the optic nerve, by an encyſted tumor in the orbit, with gradual recovery after operations. See Med. Ob. and Inquir. vol. iv. p. 371.

‡ De Ocul. Affectibus, Ob. 2.

edneſs, ſo that objects are ſeen only when near the eye. Thus far we might account for the defect of viſion by the alteration of the focus of the cornea and humors; but, by and bye, as the eye enlarges, as it becomes turgid, and the coats more diſtended, the pupil becomes ſtationary, and the viſion is loſt before the aqueous humor has become turbid *.

The connexion and ſympathy betwixt the retina and the viſcera of the abdomen is very particular: I have ſeen a proof of this in the diſorder of the ſtomach having an immediate effect on the ſenſibility of the retina. Allied to this, but greater in degree, is the amauroſis which attacks hyſterical women ſuddenly, with head-ach and violent pain. From ſuch ſympathy of parts ariſe the amauroſis biloſa, verminoſa, intermittens, arthritica, &c. Such attacks of blindneſs have been found to alternate with convulſions †.

The amauroſis is a total blindneſs, while there is a tranſparency of the humors and coats of the eye. AMBLYOPIA is, on the contrary, only a partial privation of ſight, with a pellucid ſtate of the eye. Such as occurs in old age from diminiſhed ſenſibility.

Commencing cataracts and opacities of the cornea, and of the humors in general, give occaſion to ſpots and

* To complete ſuch a caſe, we may further obſerve, that there is now an acceſſion of pain, a tenſion over the forehead and pericrania, and there is ſometimes accompanying it a ſwelling and inſenſibility of the ſide of the face. So luxation or diſplacement of the eye, by tumors, cauſes blindneſs, by extending the optic nerve or compreſſing the eye-ball and conſequently the retina.

† The following is an ingenious account of the manner in which this may be produced, though to me it is not ſatisfactory: —" Non infrequens cæcitas poſt convulſiones graves et frequentes, ſed a nemine quod ſciam recte deſcripta cauſa; hanc non ab humoris affluxu deduco, ut voluerunt, ſed quia in magnis illis per paroxyſmas convulſionum partium omnium, et oculorum ſimul contorſionibus in quibus ſæpe quoque convulſi, admodumque exerti et inflexi apparent, attracto ſic nimium et tenſo nervo optico, illis adnato illoque ſimul contorto et læſo, ſpiritusque viſorii tranſitu impedito, oculos viſione privari contingit, atque inde provenire diligente examine & conſideratione invenimus." Platerus Prax. lib. i. c. 7.

obſcurities in the viſion *; but we have at preſent to conſider thoſe only which depend on the ſtate of the nerve †. Errors of viſion are not eaſily to be diſtinguiſhed from thoſe of the imagination proceeding from the brain. Error opticus, or hallucinacio, from delirium: one diſtinction of the former is, that we can correct the deception by the aſſiſtance of the other ſenſes, while, in the latter, the mind is diſeaſed.

Old people are often troubled with the appearance of dark irregular ſpots flying before their eyes. In fever, alſo, it is very common to ſee the patient picking the bed-cloaths, or catching at the empty air. This proceeds from an appearance of motes or flies paſſing before the eyes, and is occaſioned by an affection of the retina, producing in it a ſenſation ſimilar to that produced by the impreſſion of images; and what is deficient in the ſenſation, the imagination ſupplies; for, although the reſemblance betwixt thoſe diſeaſed affections of the retina and the idea conveyed to the brain may be very remote, yet, by that ſlight reſemblance, the idea, uſually aſſociated with the ſenſation, will be excited in the mind.

M. de la Hire attributed the fixed ſpots to drops of extravaſated blood on the retina, and the flying ones,

* CALIGO is an obſcurity in the viſion, depending on obſtruction to the rays, from opacities before the pupil. "CATARACTA opacitas eſt ultra pupillam." AMBLYOPIA and AMAUROSIS are occaſioned by the diſeaſe of the nerve, or confuſion from the focal powers of the humors without opacity of any part. But Cullen extends the genus CALIGO to all obſcurities cauſed by opacity: he introduces the words "ob repagulum opacum, inter objecta & retinam," while Sauvage has the expreſſion "repagulum opacum citra pupillam."

† PSEUDOBLOPSIS is thus defined by Dr. Cullen: "Viſus depravatus ita ut quæ non exiſtant homo ſe videre imaginatur vel quæ exiſtunt aliter videt ac revera ſe habeant" — under this genus is SUFFUSIO, PHANTASMA. Under this definition all deceptions from refraction of the rays are naturally comprehended, as well as from the imagination ſimply: a definition comprehending defects of viſion which proceed from cauſes ſo very diſtinct, is an obſtruction to the knowledge of diſeaſes. Sauvage has it claſſed with the veſaniæ, viz. G. ſuffuſio, hallucinatio viſus circa objecta.

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to motes in the aqueous humors *; but we ſhall ſhow preſently, that this apparent motion of the motes before the eyes may be a deception. After turning round upon the heel for ſome time, objects apparently continue in motion. Dr. Porterfield ſuppoſed this to proceed from a miſtake with reſpect to the eye, which, though it be at reſt, we conceive to move the contrary way to that in which it moved before; from which miſtake, with reſpect to the motion of the eye, the objects at reſt will appear to move the ſame way the objects are imagined to move, and, conſequently, will ſeem to continue their motion for ſome time after the eye is at reſt. How ſuperior is ſimple experiment to the moſt ingenious ſpeculation! Dr. Porterfield is preſuming in all this, that the eye is at reſt when the body is ſtationary, after turning round rapidly on one foot. But the fact is, that the eyes continue in motion after the body is at reſt, but owing to a diſorder in the ſyſtem of ſenſation we are not ſenſible of it. Dr. Wells, in making an experiment, in which it was neceſſary to look upon a luminous body, was ſeized with giddineſs, and he found, that the ſpot on the retina, affected by the great excitement of the luminous body, did not remain ſtationary, but, when made apparent by looking upon the wall or any plane, was moved in a manner altogether different from what he conceived to be the direction of his eyes. In making the experiment after looking ſome time at a candle, and then turning himſelf round till he became giddy, he afterwards directed his eyes to the middle of a ſheet of paper, he ſaw the dark ſpot (cauſed by the former brilliancy of the candle on the retina) take a courſe over the paper, although he conceived that the poſition of his eyes remained ſtationary. He then directed a perſon to repeat this experiment, and then bade him look ſteadfaſtly to him, and keep his eyes fixed; but inſtead of

* "Guttula cruoris retinæ inſidens et nigricans, omnem lucem intercipiet unde phantaſma obſcurum vel nigrum; verum ſi dilutus cruor radios rubros tranſmittat tunc maculam rubram videbit æger ut omnia trans vitrum inſpecta rubra ſunt." Sauvage, vol. iv. p. 287.

keeping

keeping ſtationary, his eyes were ſeen to move in their ſocket; though, of this the perſon himſelf was quite inſenſible.

From theſe experiments, we may conclude, that ſpots which ſeem to move before the eyes are not, on that account, ſolely to be attributed to opacity of the humors or cornea, ſince the appearance of motion may be given to thoſe motes, though occaſioned by an affection of the nerve; eſpecially, if the unuſual ſenſation be attended with giddineſs. Giddineſs, however, is not neceſſary to ſuch ſenſation; when my eyes are fatigued, and, ſitting in my room, I look towards the window, I ſee before me ſmall lucid circles which ſeem to deſcend in quick ſucceſſion; upon attending more particularly to my eyes, I find them in perpetual motion; my eye is turned gradually downward, which gives to the ſpectrum the appearance of deſcending; but it regains its former elevation with a quick and imperceptible motion. During the ſlow inclination of the eye downward, the motes or little rings ſeem to deſcend; but in lifting the eye again, the motion is ſo quick, that they are not perceived *.

There is a kind of umbræ ſeen before the eyes which are occaſioned by the veſſels of the retina. Of this kind is the ſuffuſio reticularis of Sauvages, in which the per-

* The following quotation refers to this ſenſation: —"Aeger in magna luce conſtitutus, ut plurimum preſbyta, vel oculis nitidiſſimis gaudens continuo præ oculos obſervari ſibi putat puncta lucida, quæ non huc et illuc volitant, nec a commoto capite agitantur, ut putat la Hire, et ejus in hoc exſcriptor Boerhaave; ſed conſtanter ſi oculus immobilis remaneat, deorſum lentiſſime delabi videntur; adeoque veluti pluvia aurea præ oculos eaque denſa cernitur; quæ verticaliter ſemper deſcendit in quacumque capitis poſitura, ſive erecta, ſive lateraliter inclinata; hoc in me ipſo expertus per annos, obſervavi in aliis, potiſſimum illos qui ſtudio nocturno indulſerant, et in aegrotante, qui de eo ſymptomate ad melancholiam fere per multos annos ſollicitus erat." Sauvages. This appearance has been attempted to be explained upon the ſuppoſition of a very ſenſible ſtate of the retina, which perceives the gutulæ exuding from the pores of the cornea, and which, falling over its ſurface, gives the appearance of their deſcending. But it is only felt when the retina is exhauſted or diſturbed by preſſure on the eye-ball. See Sauvages Suffuſio Scintillans & Suff. Danaës.

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ſon ſees umbrageous ramifications which ſtrike acroſs the ſphere of viſion, and are ſynchronous with the pulſe, ſhowing its dependance on the full and throbing pulſation of the head. There are alſo corruſcations ſeen before the eyes in conſequence of a blow upon the eye-ball, and accompanying violent head-ach, vertigo, phrenitis, epilepſy, &c. Whatever forces the blood with great violence to the head, as coughing, vomiting, ſneezing, will cauſe, for the inſtant, ſuch corruſcations, by means of the diſturbed circulation through the retina.

We are particularly called upon to attend to the connection betwixt the iris and the retina. In amauroſis, the ſenſibility of the retina being entirely loſt, the pupil is conſequently immoveable and dilated *. But we muſt recollect, that if one eye be ſound, the pupil of the diſeaſed eye follows, in ſome degree, the movement of the iris of the ſound eye. If one eye be ſhut, the pupil of the other eye will dilate; if the hand be put over the eye-lids of the ſhut eye, the pupil will ſtill further dilate †.

We find ſeveral inſtances of viſion indiſtinct during full day-light, and perfect in the crepuſculum. This we have explained by the dilatation of the pupil allowing the rays of light to paſs the partial opacity of the lens; it, of courſe, has no connection with the diſeaſe of the retina.

There are alſo inſtances of viſion being more than naturally obſcure in the twilight, which is owing to a de-

* There are, however, caſes of AMAUROSIS A MYOSI, in which there is a contracted and immoveable pupil, and children are born with an inſenſibility of the organ in which the pupil is not greatly dilated. I would be willing to attribute this peculiarity of the pupil and apparent amauroſis in newly born children to the remains of the membrana pupillaris.

† The ſympathy of the iris with the retina I do not conceive to be immediate, but through the intervention of the brain; and the degree of dilatation of the pupil, I ſhould hold to depend on the ſtrength of the common ſenſation of both eyes. By this only can we account for the ſenſibility of the retina of one eye affecting the iris of the other, or the diſturbance of the brain, in comatoſe diſeaſes, deſtroying the ſympathetic connection betwixt the retina and pupil.

gree of inſenſibility *. The night blindneſs, however, is not to be entirely attributed to a degree of continued inſenſibility in the nerve. The attacks are irregular, and allied to the intermitting amauroſis. It has been epidemic, and the following caſes ſeem to ally it with the paralytic affections.

CASE I. OF NYCTALOPIA, OR NIGHT BLINDNESS, BY DR. HEBERDEN.

A man, about 30 years old, had, in the ſpring, a tertian fever, for which he took too ſmall a quantity of bark, ſo that the returns of it were weakened without being entirely removed; he therefore went into the cold bath, and after bathing twice, he felt no more of his fever. Three days after his laſt fit, being then employed on board of a ſhip, in the river, he obſerved, at ſun-ſetting, that all objects began to look blue, which blueneſs gradually thickened into a cloud, and not long after he became ſo blind as hardly to perceive the light of a candle. The next morning, about ſun-riſe, his ſight was reſtored as perfectly as ever. When the next night came on, he loſt his ſight again in the ſame manner; and this continued for 12 days and nights. He then came aſhore, where the diſorder of his eyes gradually abated, and in three days was entirely gone. A month after, he went on board of another ſhip, and after three days ſtay in it the night-blindneſs returned as before, and laſted all the time of his remaining in the ſhip, which was nine nights. He then left the ſhip, and his blindneſs did not return while he was upon land. Some little time afterwards, he went into another ſhip, in which

† Eſt immanis differentia inter ſplendorem et activitatem luminis candelæ et lunæ: luminis ſolaris vis eſt ad vim luminis candelæ 16 pedes diſtantis, obſervante D. Bouguer ut 11664 ad 1; et ad lumen lunæ in plenilunio, ut 374,000 ad 1 demonſtrante D. Euler Mem. de l'Acad. de Berlin, an 1750, pag. 299. non mirum itaque ſi vis toties major ſufficeret ad ſuccutiendam retinam quam tanto minor non afficiebat. *Sauvages Amblyopia Crepuſcularis.*

he continued ten days, during which time the blindneſs returned only two nights, and never afterwards.

In the Auguſt following, he complained of loſs of appetite, weakneſs, ſhortneſs of breath, and a cough; he fell away very faſt, had frequent ſhiverings, pains in his loins, dyſury, and vomitings; all which complaints encreaſed upon him till the middle of November, when he died. He had formerly been employed in lead-works, and had twice loſt the uſe of his hands, as is uſual among the workers in this metal. Medical Tranſactions, publiſhed by the College of Phyſicians in London, vol. i. p. 60.

CASE II. OF NYCTALOPIA, BY DR. SAMUEL PYE.

Pye, ſervant to a miller, at the 6th mill on the Limehouſe wall, about 40 years of age, came to me October 2d, 1754, for advice and aſſiſtance. He told me, that about two month ago, while he was employed in mending ſome ſacks, near the ſetting of the ſun, he was ſuddenly deprived of *the uſe of his limbs* and of his ſight. At the time he was attacked with this extraordinary diſeaſe, he was not only free from any pain in his head or his limbs, but, on the contrary, had a ſenſation of eaſe and pleaſure; he was, as he expreſſed himſelf, as if in a pleaſing doſe; but perfectly ſenſible. He was immediately carried to bed, and watched till midnight; at which time he deſired thoſe who attended him, to leave him, becauſe he was neither ſick nor in pain. He continued the whole night totally blind and without a wink of ſleep.

When the day-light of the next morning appeared, his ſight returned to him gradually as the light of the ſun encreaſed, till it became as perfect as ever; when he roſe from bed, his limbs were reſtored to their uſual ſtrength and uſefulneſs, and himſelf in perfect health.

But on the evening of the ſame day, about the ſetting of the ſun, he began to ſee but obſcurely, and his ſight gradually departed from him, and he became as blind as

on the preceding night; though his limbs continued as well as in perfect health; nor had he, from the first night, any complaint from that quarter.

The next day, with the rising sun, his sight returned; and this has been the almost constant course of his disease for two months past. From the second night, the symptoms preceding the darkness were a slight pain over the eyes, and a noise in his head, which he compared to a squashing of water in his ears.

After near two months continuance of the disease, on September the 29th, the patient was able to see all night; on the 30th September, October 1 and 2, he was again blind all night; on the 3d, he was able to see; on the 4th, he was blind till 12; on the 5th, was blind. From this he had no return of his complaint till June 1755; from which time till the 3d of October, when I again saw him, he had three or four attacks; from the 3d till the 10th, he had an attack every evening.—He had at this time a purging. I ordered him an electuary of bark and nutmeg, which succeeded in removing the blindness; but the diarrhæa continued wasting him. On the 20th, delirium came on; on the 21st, he became deaf; he died on the 25th, after having suffered from fever, pain in his bowels, and continued diarrhæa; but the defect in his eyes never returned after the 10th. This man had clear bright eyes: when his sight failed him the pupils were enlarged about one-third in diameter. Medical Facts and Enquiries, vol. i. p. 111.

Boerhaave gives us an example of imperfect vision, from a discordance betwixt the contraction of the iris and the excitement of the retina; so that the pupil did not dilate in the proportion to the decay of light *.

When inflammation extends within the eye, or when the retina is excited by sympathy with the ophthalmia of the outer membranes, it may happen that the patient is totally blind during the day, and yet sees on the ap-

* In old people there is an obscurity of vision, from a diminished sensibility of the retina; and the iris does not take a quick succession of contraction and dilatation with the change of light.

proach of evening; becaufe, from the fenfibility of the retina, the pupil is abfolutely fhut, but as the light is diminifhed the pupil is gradually relaxed, and the obfcure light admitted, and this obfcure light, from the irritable ftate of the retina, gives a vivid fenfation incomprehenfible to the byftanders. Our judgments of the ftrength of fenfations are comparative merely; when we have been accuftomed to ftrong impreffions, leffer ones are difregarded. The greater light deftroys the capacity of the retina for receiving flighter and more delicate impreffions; while, on the other hand, the abfence of light referves to us the power of feeing objects the moft faintly illuminated. We are every day becoming more acquainted with the invifible properties of light; and we have frequent experience of darknefs being relative, and that what we fhould call total darknefs is very often but a fainter light. One man will fee diftinctly, when another is quite deprived of the power of difcerning objects. A man in prifon feems to have the light gradually admitted to him; and many animals are in quick purfuit of their prey, while we are groping our way with the affiftance of our other fenfes.

Animals which feek their prey in a light which is darknefs to us, have, moft propably, a greater degree of fenfibility of the retina. But they have alfo a more confpicuous apparatus in the largenefs of their eyes, and the dilatability of their pupil, while the fenfibility which this provifion gives, is often guarded from the light of day by the membrana nictitans, and by an iris capable of great contraction. Their iris poffeffes alfo a great power of contraction in narrowing the pupil during the day, as it is capable of dilating during the night, to the whole extent of the cornea. In the human eye, alfo, the ftrict fympathy between the iris and retina is a guard to the latter. But it has often happened that, in ufing optical inftruments, the retina has been hurt by the intenfity of the light from the concentrated rays: a leffer degree of this effect we have given us in the following inftance *:

* Viz. by Dr. Reid.

"Being occupied in making an exact meridian, in order to obſerve the tranſit of Venus, I raſhly directed to the ſun, by my right eye, the croſs hairs of a ſmall teleſcope. I had often done the like in my younger days with impunity; but I ſuffered by it at laſt, which I mention as a warning to others. I ſoon obſerved a remarkable dimneſs in that eye, and for many weeks, when I was in the dark or ſhut my eyes, there appeared before the right eye a lucid ſpot, which trembled much like the image of the ſun ſeen by reflection from water. This appearance grew fainter, and leſs frequent by degrees, ſo that now there are ſeldom any remains of it. But ſome other very ſenſible effects of this hurt ſtill remain:—For, firſt, the ſight of the right eye continues to be more dim than that of the left; ſecondly, the neareſt limit of diſtinct viſion is more remote in the right eye than in the other, although, before the time mentioned, they were equal in both theſe reſpects, as I had found by many trials; but, thirdly, what I chiefly intend to mention is, that a ſtraight line, in ſome circumſtances, appears to the right eye to have a curvature in it. Thus, when I look upon a muſick book, and, ſhutting my left eye, direct the right to a point of the middle line of the five which compoſe the ſtaff of muſick, the middle line appears dim indeed at the point to which the eye is directed, but ſtraight; at the ſame time the two lines above it and the two below it appear to be bent outwards, and to be more diſtinct from each other, and from the middle line, than at other parts of the ſtaff to which the eye is not directed. Fourthly, although I have repeated this experiment times innumerable within theſe 16 months, I do not find that cuſtom and experience takes away this appearance of curvature in ſtraight lines. Laſtly, this appearance of curvature is perceptible when I look with the right eye only, but not when I look with both eyes; yet I ſee better with both eyes together than even with the left eye alone."

Herſchel, in making his obſervations on the ſun, found the irritation proceeding from the red rays * (being thoſe

* See a curious inſtance of red colours producing convulſions in an epileptic patient. Sandifort Theſ. vol. iii. pag. 314.

of

of the rays of light which have the property of producing heat in the greateſt degree); he found, when he uſed red glaſs to intercept the too vivid impreſſion of light on his eyes, that they ſtopped the light but produced an inſufferable irritation from the degree of heat. But when he uſed green glaſs, it tranſmitted more light, and remedied the former inconvenience of an irritation ariſing from heat. He concluded, that in the darkening glaſſes for teleſcopes, the red light of the ſun ſhould be entirely intercepted. Boerhaave mentions an inſtance of the retina being injured by the long uſe of the teleſcope, and he himſelf was hurt by a ſimilar cauſe. Theſe injuries are owing to the intruſion of light highly concentrated, and over which the pupil has no command; it is a degree of intenſity which the organ is not prepared to counteract.

CHAP. VI.

OF THE MEMBRANA PUPILLARIS.

THE membrana pupillaris is an extremely vaſcular membrane, which is extended acroſs the pupil of the fœtus. It was diſcovered by Haller, Albinus, Wachendorf *, and Dr. William Hunter, at the ſame time or without correſpondence with each other. Haller †, after injecting, with oil of turpentine and cinnabar, a fœtus of the ſeventh month, ſaw through the cornea the veſſels of the iris injected, and ſome ramifications from them produced into the ſpace of the pupil. From conviction that no veſſels ramified without an involving membrane, he naturally concluded, that a membrane was drawn acroſs the pupil of the fœtus, though, in this inſtance, it was about to diſappear.

* In Commercio Norico, A. 1740, hebd. 18. as quoted by Haller.

† De nova tunica pupillam fœtus claudente. Oper. minor.

In ſeveral other fœtuſes of the ſeventh month he confirmed his firſt obſervation; and, cutting off the cornea, he obſerved the membrane impelled forward by the humors behind like a little veſicle.

Albinus, in his firſt book of Academical Annotations, thus deſcribes the way in which he detected this membrane. In the ſame child in whom he had filled the veſſels of the chryſtalline, he alſo firſt obſerved the membrane which cloſes the pupil, and in which the veſſels were injected that came from the margin of the pupil. Upon looking through the cornea, he could ſee no diſtinction of parts, but all ſeemed vaſcularity. He conceived, at firſt, that theſe were the veſſels of the uvea, and that it had quite contracted and had ſhut the pupil; then that they were the veſſels of the capſule of the cryſtalline lens; but having cut into the eye, he found it to be this membrane. Dr. Hunter, ſpeaking of this membrane, and of Albinus's claim to the diſcovery, ſays, "In juſtice to this great anatomiſt, I muſt declare that I believe this, both becauſe he aſſerts it and becauſe I know from the circumſtances it was hardly poſſible he could miſs taking notice of it in that child." "I have always obſerved (he continues), both in the human body and in the quadruped, that there is a great reſemblance to one another in the veſſels of the capſula criſtallini and of the membrana pupillæ. In an injected fœtus, I always find both nearly in the ſame ſtate: if one be filled only with the blood that is drove before the injection, ſo is the other; if one be filled partly with injection, and partly with blood, the other is in the ſame condition; if one, by good fortune, be finely and minutely filled with injection, the other is ſo too; if one be burſt by extravaſations, the other is commonly in the ſame ſtate; and when the fœtus is ſo near its full time that the one cannot be injected, neither can the other *."

Dr. Hunter, ſpeaking further of the artery of the chriſtalline capſule, ſays, "that it does not terminate at

* See Medical Commentaries, p. 63, foot note.

the

the great circle of that humor. Its ſmall branches paſs that circle, and run a very little way on the anterior ſurface of the chriſtalline humor before the points of the ciliary proceſſes; then they leave the humor and run forwards, ſupported on a very delicate membrane, to loſe themſelves in the membrana pupillæ." He continues: "The membrana pupillæ receives two different ſets of arteries, one larger, from the iris, and the other much ſmaller, but very numerous from the chriſtalline capſule."

Now I think that every expreſſion in theſe excerpts confirms the opinion I entertain, that theſe veſſels which are ſeen filled with red blood, and which take their courſe through the humors, are ſubſervient merely to the membrana pupillaris.

The firſt time I obſerved the membrana pupillaris was in the eye of a child born at the full time. I had injected the child very minutely with ſize and vermillion, and the iris was beautifully red and the pupil quite tranſparent and black, and not obſcured by any extravaſation of the injection into the aqueous humor: upon very narrowly obſerving the circle of the iris, I ſaw diſtinctly a ſmall injected veſſel paſs out from the edge of the iris, and croſſing the pupil, divide into two branches which ran into the oppoſite margin of the iris. This was the remains of the membrane, but ſo delicate and ſo perfectly tranſparent, that the preſence of it was only to be argued from the veſſel which was ſeen to croſs the pupil.

Since that time I have often ſeen it in the early months, and particularly ſtrong about the ſeventh month of the fœtus. It is then an opaque, and very vaſcular membrane, and generally it has ſpots and ſtreaks of extravaſation in it. The vaſcular ſtructure of this membrane is very particular, and I can aſſign no other reaſon for this than that it may be a proviſion for its rapid abſorption. It has evidently two ſources of veſſels, viz. the veſſels of the capſules and thoſe of the iris; but whether the arteries come by the one ſource, and the

the veins depart by the other, I cannot as yet determine. In one preparation I ſee the veſſels with their trunk in the membrana pupillaris, and the branches ſent over the ſurface of the iris.

The larger and flat venous-like veſſels of the membrane are diſtributed in a beautiful net-work, in the form of the lozinge of a Gothic window. They have a free communication with each other. In their whole courſe the veſſels ſeem nearly of the ſame ſize, which alſo is (like the character of a venous net-work), and they terminate apparently in the margin of the iris.

The uſe of the membrana pupillaris I think ſufficiently apparent, though I do not find that it has hitherto been underſtood. Haller makes a compariſon betwixt this membrane, which cloſes up the pupil, and that matter which is accumulated in the paſſage of the ear in the fœtus. But there is no analogy. — As the waters of the amnios might otherwiſe be in contact with the membrane of the drum of the ear, and injure what neceſſarily is of a dry and arid nature, this matter accumulated in the ear of the fœtus defends it. But at the time, when the membrana pupillaris exiſts in its full ſtrength and vaſcularity, no light is admitted into the eye — the fœtus is lying in its mother's womb. Towards the ninth month, the membrane has become tranſparent, and if not totally abſorbed, it is torn by the firſt motion of the pupil and altogether diſappears. It can therefore have no effect in obſcuring the light, and preventing it from exciting in too great a degree the eye of the newly-born child. To explain the effect of this membrane, then, we have only to conſider that it is of the nature of the iris to contract its circular fibres during the operation of light, ſo as to cloſe or nearly cloſe the pupil; that, on the other hand, the pupil is completely dilated through the operation of the radiated fibres of the iris in darkneſs: — To the queſtion, then, why it is not dilated during the fœtal ſtate? The anſwer, I think, is decidedly this: — The iris is not looſe in the fœtal ſtate, it is connected and ſtretched to the middle degree of contraction

traction and dilatation by the membrana pupillaris. Were the iris in a full ſtate of contraction, during the life of the fœtus, it could not receive its full nouriſhment, proper degree of extenſion, and due powers; but being preſerved ſtationary and extended, the diſpoſition to contraction, which it muſt have when the retina is without excitement, is counteracted, until it is about to receive, by the birth of the child, that degree of excitement which is to keep up the preponderance towards the contracted ſtate of the pupil.

CHAP. VII.

OF THE HUMORS OF THE EYE.

OF THE AQUEOUS HUMOR.

THE aqueous humor is perfectly limpid. It has no capſule or ſurrounding membrane, as it is not in conſiſtence allied to the other humors, but is fluid *. The uſe which I have aſſigned to the aqueous humor explains its nature and the extent of the chamber which contains it, viz. that it diſtends the cornea and allows the free motion of the iris ; it conſequently fills the ſpace between the lens and cornea. The uſual deſcription is, that it is lodged in two chambers ; the one before the iris, called the anterior chamber of the aqueous humor, and the other behind the iris, called the poſterior chamber of the aqueous humor.

This poſterior chamber, was, at one time, conceived to be of great extent †, and authors ſpoke of depreſſing the lens into the poſterior chamber of the aqueous humor.

* It poſſeſſes, however, a degree of viſcidity. Winſlow.

† Viz. by Heiſter. They were called the firſt and ſecond chambers by M. Briſſeau.

mor *. It is found, now, that betwixt the lens and iris there is no ſpace to which we ought to give this name of chamber.

Heiſter, Morgagni, and M. Petit (medecin) firſt demonſtrated the extreme ſmallneſs of the poſterior chamber, and after them Winſlow confirmed the fact, that the iris moved almoſt in contact with the anterior ſurface of the lens.

M. Petit gave the cleareſt proof of the ſmallneſs of the poſterior chamber, by freezing all the humors of the eye, and diſſecting them in their ſolid ſtate. Without this expedient it was impoſſible to prove the relative ſize of the two chambers; for, whenever the cornea was cut, the aqueous fluid eſcaped, and the lens puſhed forward. When the eye was frozen, and then diſſected, it was found that the ice, which took the ſhape and dimenſions of the anterior chamber, was much larger than that found in the poſterior chamber †; indeed the latter was formed of a very thin flake of ice. The thin piece of ice in the poſterior chamber indicated as much fluid only betwixt the iris and lens as might allow a free motion to the iris. Theſe experiments were inſtituted in the courſe of inveſtigating the queſtion of the nature of the cataract.

The concluſion, that the poſterior chamber of the aqueous humor contained but one-fourth of the whole aqueous humor, was admitted with great difficulty and after much conteſt. It determined the queſtion, whether the cataract was a membrane or the opaque lens; for, as thoſe who maintained that it was a membrane, ſaid it could not be the lens, becauſe the lens was far diſtant from the iris, it was neceſſary for their opponents to prove that the lens was cloſe upon the pupil, and that the poſterior chamber of the aqueous humor was very ſmall.

* There certainly appears ſufficient room for this in Veſalius and Briggs' plates: theſe plates have miſled many.

† See Acad. Roy. des Sciences, 1723. Mem. p. 38.

It

It is agreed that, in the adult, the quantity of the aqueous humor amounts to five grains; in the fœtus it is red, turbid, and weighs about a grain and a half, owing, in part, to the comparatively greater thickneſs of the cornea.

As it is natural to conceive that the aqueous humor flows from a vaſcular ſurface, it is the moſt generally received opinion, that it is derived from the points of the ciliary proceſſes and ſurface of the iris. Haller, particularly, and after him Zinn, have thought that the ciliary proceſſes were the ſecreting bodies; but there is one argument which, in my mind, determines that theſe are not the ſole ſecreting parts, viz. that while the membrana pupillaris cloſes up the communication betwixt the two chambers, I have obſerved the anterior one to be full of the fluid, which of courſe muſt have been ſupplied from another ſource than the ciliary proceſſes. I ſuppoſe, therefore, that the villous ſurface of the iris is the proper ſecreting ſurface of the aqueous humor *. Zinn obſerves, that Haller ſaw the membrana pupillaris diſtended and bulged forwards by the aqueous humor in the poſterior chamber. It is ſcarcely neceſſary to ſay, that this muſt always take place when the cornea is firſt opened in demonſtrating that membrane, whether there be a watery fluid behind it or not. But I believe I ſhall be able to prove, that the ſecretion of the ciliary proceſſes can have little power of filling the poſterior chamber, even from the connection of membranes behind the membrana pupillaris in the fœtus. The aqueous fluid is perpetually undergoing the change of ſecretion and abſorption, and this is the reaſon of its quick renewal when it has been allowed to eſcape by puncture of the cornea.

* The opinion of Nuck is now out of the queſtion. He thought that he had diſcovered particular aqueducts, which conveyed the aqueous humor into the anterior part of the eye; but theſe are found to be nothing more than the ſhort ciliary arteries which pierce the fore part of the ſclerotica. M. Merry and Bonhomme (ſee Zinn, p. 143.) obſerved, in an adult, the pupil cloſed with the membrane, and, in this inſtance, there was ſcarcely any fluid in the anterior chamber, whilſt the poſterior was turgid with fluid.

The

The ancients were not ignorant of the quick regeneration of this fluid. It was proved to the moderns by a charlatan, Josephus Burrhus (ventosus homo, qui in carcere Romano periit). Before the physicians of Amsterdam he punctured the cornea of a dog; then instilling his liquor under the cornea, he bound up the eye; in a few days he took off the bandage, and showed them the cornea again distended with the aqueous humor. It was soon found that the instilled fluid was of no kind of consequence. Redi and Nuck made many experiments, and it was found that the aqueous humor was regenerated in the course of 24 hours.

When the disputes regarding the cataract ran high, and when, to make new distinctions in the disease was taken as a mark of practical knowledge and of acuteness, there was a kind of cataract attributed to the aqueous humor. When the aqueous humor became turbid, white, and opaque, and obscured the pupil, they were absurd enough to call this a cataract. The turbid state of the aqueous humor is at once distinguishable, from the opaque lens, because it obscures the iris as well as the pupil.

Pus is formed in the chambers of the aqueous humor, in consequence of deep inflammation, contusions, &c. and from the same cause, sometimes, proceeds a bloody effusion. When the pus has lodged in the anterior chamber of the aqueous humor, it would appear, upon the authority of Galen, that an oculist of his day performed a cure by shaking the patient's head *! It is an operation of oculists to puncture and allow the pus to flow out, and some have even syringed out the pus with water†; but this must have been on the principles of Jos. Burrhus's exhibition; for the natural secretion is here

* Mouchart says, he has often seen the oculist Woolhouse repeat this cure by shaking his patient's head over the side of the bed. He attributed the cure to the falling of the pus into the posterior chamber, which, he supposes, has parts more capable of absorbing it.

† They were at variance regarding the place at which to puncture for this discharge: — Some did it behind the iris; there we know there

here the beſt diluent. When we recollect the nature of the parts with which the pus lies in contact, we cannot be ſanguine in the hope of ſuch an operation ſaving the eye. Sometimes there remains, after operation on the cornea, or in conſequence of ulceration, a continued flow of the aqueous humor; the conſequence is a ſubſiding of the cornea *: it becomes corrugated, opaque, and, from the contact of the iris, apt to adhere to the iris. In conſequence of this ſuppuration, there ſometimes follows an abſolute obſtruction of the pupil, from the coaleſcing and adheſion of the edges of the iris †.

THE VITREOUS HUMOR.

The vitreous humor, as already explained, occupies almoſt entirely the great ball of the eye. It is conſequently beyond the lens, and keeps it at the requiſite diſtance, to cauſe the rays from objects to concentrate and impinge upon the retina. The vitreous humor is conſiderably denſer than the aqueous humor ‡. Its involving membrane is called membrana hyoloides ſive vitrea §. The peculiar appearance of this humor, its glairy-like conſiſtence, is not owing to its denſity, but to the manner in which it is contained in its membranes. From being contained in a cellular ſtructure of perfectly pellucid membranes, it has the adheſion and conſiſtence of the white of an egg. This membranous ſtructure of the vitreous humor has been demonſtrated by acids and by freezing. When frozen, it was found to conſiſt of pieces of ice connected by ſtrong membranes, which ſeparated with difficulty, and ſhowed their torn fragments; and M. De-

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there is a crowd of veſſels; the beſt place is the lower edge of the cornea before the iris. It ſeems to have been no uncommon accident, in this operation, to find the lens protruded through the pupil. The reaſon of this has been already explained.

* Rhytidoſis, ſeu ſubſidentia & corrugatio corneæ.

† Viz. Syniſeſis. There has occurred congenital imperforation of the pupil.

‡ It is, according to Dr. Monro, in the proportion of as 1016 to 1000.

§ *Ophthalmo graphia* authore G. Briggs, 1676. Cantab.

mours

mours lifted the tranſparent membranes with the point of a needle. Although the vitreous humor appears to be gelatinous, it is not ſo in reality, and when it is taken from the coats of the eye, it retains the ſhape for a time, but gradually ſubſides by the fluid exuding from the membranes, and this is accelerated by puncturing it.

OF THE CHRISTALLINE LENS.

The chriſtalline humor is a ſmall body, of the ſhape of an optician's lens, of great power. It is of perfect tranſparency, and of denſity much greater than the vitreous humor. Its denſity to that of the vitreous humor is calculated to be as 1114 to 1016. But the chriſtalline is not of uniform denſity, for the centre forms a denſer nucleus.

The form of the chriſtalline is that of a compreſſed ſphere, the anterior ſurface being more compreſſed or flatter, though, in a degree, convex. According to Petit, the anterior ſurface is the ſegment of a ſphere whoſe diameter is 7, 8, or even 9 lines. The poſterior ſurface is a ſphere of 4 or 5, or 5½ lines in diameter. The internal ſtructure of the lens is quite peculiar, and reſembles neither the vitreous nor the aqueous humor. By maceration, it ſplits into lamellæ, and at the ſame time burſts up into equal parts, ſo that there is firſt a ſtellated-like fiſſure, and then it ſeparates into pretty regular diviſions; and after maceration in acids, the lens can be teaſed out into minute ſhreds and fibres *.

From its form, denſity, and central nucleus, it has great power of converging the rays of light; and in an eye properly conſtituted, it concentrates them accurately to the ſurface of the retina. For this reaſon, it is placed before the vitreous humor, and ſocketed in its anterior part. It is contained in a capſular membrane, the *tunica aranea* improperly called †, which membrane is continued from, or connected with, the membranes of the vitreous humor; but this is a ſubject which requires a more particular inveſtigation.

* See further of the muſcularity of the lens † *Ophthalmographia.*

OF

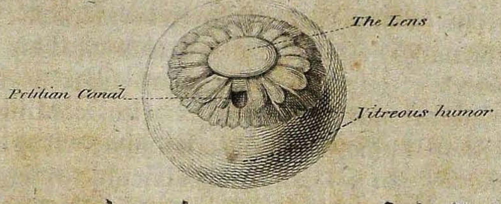
OF THE CAPSULE OF THE LENS AND VITREOUS HUMOR.

Marg. Plate 13.

Fig. 2.

Fig. 3.

Fig. 1.



In fig. 1. we have the appearance of the Petitian canal blown up. It is not found full of any fluid, it is only the laminæ of membrane inflated, and it is beſt demonſtrated by cutting off the cornea, and with it a ſmall circular portion of the ſclerotica, and taking with theſe the iris alſo, when the lens preſents itſelf ſeated firmly in its capſule on the vitreous humor. Now laying back the ciliary proceſſes, we make a fine puncture with a lancet by the ſide of the lens, and then blow gently into it with the blow-pipe.

Every anatomiſt acknowledges the exiſtence of the Petitian canal, and a diſtinct capſule to the lens is alſo pretty generally allowed. But many deny that the vitreous membrane has two plates, without obſerving that the exiſtence of the Petitian canal is a proof of the ſplitting of the membrana vitrea, on the fore part at leaſt. Some believe that the vitreous membrane ſplits and involves the lens, and forms its capſule; but the difficulty, on this ſuppoſition, is ſtill to account for the formation of the canal which ſurrounds the lens; for as the fluids on the ſurface of the lens and within its capſule have not admiſſion to the canal, the canal muſt be diſtinct; and, indeed, ſometimes we blow up the circular canal, and ſometimes, by a wrong puncture, the capſule of the lens itſelf; but not both at once.

 Seeing

Seeing, then, that these cavities are distinct, some anatomists have admitted that the membrana vitrea is double; that the lens has its proper capsule; and that the lamina of the vitreous membrane, coming near the margin of the lens, splits and involves it in a second coat, (as in fig. 2.) Others have supposed that the anterior layer of the vitreous humor does not pass over the anterior surface of the proper capsule of the lens, but only adheres to the edge of the capsule of the lens, and forms the Petitian canal. There are yet others who have described the membrana vasculosa of the retina as forming the capsule of the lens. This is one of those pieces of anatomy which provokes us to continued research, and mortifies us with continual disappointment. If this piece of anatomy, when investigated in the eye of an adult, is difficult to be understood, it is infinitely more complicated in the eye of the fœtus; and, for my own part, I cannot reconcile my experience with any former opinion.

I conceive that it is the membrana vasculosa tunicæ retinæ, or membrana vasculosa Ruyschii, which forms the vascular capsule of the lens in the fœtus, and also the canal of Petit in the adult. The cristalline lens has, in the first place, its proper capsule, which surrounds it on all sides: again, the transparent web of membrane that is continued onward from that part of the retina which has upon it the pulpy and nervous expansion, splits when it approaches the margin of the lens. One lamina goes round behind the lens, and the other passes a little before it, forms an adhesion to the capsule of the lens, and is then reflected off to the points of the ciliary processes and to the membrana pupillaris of the fœtus*. Betwixt these split laminæ of the con-

* In the fœtus, as far as I have observed, the proper capsule of the lens and the membrana pupillaris lie in contact, but they do not adhere; and while the membrana pupillaris is perfectly red with injection, there is none to be seen on the fore part of the capsule. There is, indeed, no part of that surface which is afterwards to secrete the aqueous humor, which could secrete that fluid, betwixt the surface of the lens and membrana pupillaris; so complete is the adhesion of the adventitious and vascular tunic of the lens to the membrana pupillaris.

tinued

tinued membrane of the retina, the canal which surrounds the lens is formed. The membrana vitrea is simply reflected over the back of the lens, and has no part in forming the Petitian canal. Where the retina advances forward upon the ciliary processes, it forms an adhesion, beyond which the medullary part is not continued; but the membrana vasculosa passing onward, as I have described, embraces the lens, and the lamina, which passes behind the lens and before the vitreous humor, receives and conveys the artery of the capsule; on the fore part of the lens the anterior lamina only touches the capsule of the lens, adheres, and is then reflected off to form the membrana pupillaris.

In this account I am supported by the most careful investigation, and by the simplicity of this system of vessels: for it will be observed, that it is on the membrana vasculosa alone that the vessels, carrying red blood in the fœtus, are supported, and that it shows throughout the same character for vascularity. Again, I think it probable that this membrane which passes before the lens, viz. the membrana pupillaris, and that which passes behind the lens, forming the vascular capsule of the lens, disappears at the same time; or if this posterior and vascular membrane which passes behind the lens is not totally absorbed, it becomes thin and more intimately united to the membrana vitrea.

CHAP. VIII.

OF THE DISTRIBUTION OF THE CENTRAL ARTERY AND VEIN OF THE RETINA.

I AM the more anxious to give the accurate distribution of these vessels, that Walter's account of them as tended much to derange that simple and natural view

view of this ſyſtem which obſervation authorizes us to take.

The arteria centralis retinæ ariſes from the ophthalmic artery*. Sometimes it is derived from the ciliary arteries before they enter the coats of the eye, and often there is more than one branch entering the optic nerve †. Ariſing from this ſource, there are many branches which are diſtributed to the retina, while a branch paſſes onward from the lamina cribroſa through the vitreous humor to the capſule of the lens. This veſſel does not paſs exactly in the centre of the vitreous humor, but to one ſide of the axis of the eye. When it arrives near the capſule of the lens, it divides into three or four branches, which, reaching the capſule, ſpread beautifully on the back part of it ‡.

The BRANCHES of the arteria centralis retinæ, which are diſtributed in the retina, are ſubſervient to its ſupport, and are conſequently as viſible in the adult as in the fœtus; and, where the membrane of the retina has been deſcribed as adhering to the point of the ciliary body, theſe veſſels of the retina unite to or inoſculate with the veſſels of the ciliary proceſſes.

Walter objects to the deſcription of the arteria centralis retinæ given by Haller and others; he ſays, decidedly, that there are no arteries diſtributed to the retina, and that anatomiſts have deceived themſelves in ſuppoſing thoſe veſſels which ramify on the retina, to be arteries, when, in reality, they are veins; he conceives, that the free return of the injection from the

* See Haller, Faſcic. vii. tab. vi. fig. 2. 4. 7.

† Haller, F. vii. p. 42.

‡ Walter (de venis oculi) ſays, the arteria centralis retinæ, having perforated the membrana hyoloidea, paſſes through the middle of the vitreous humor, and ſcatters ſome twigs on the ſmall cells of the vitreous humor. It does not, he ſays, run through the vitreous humor in a ſtraight line from behind, forward, nor does it divide into a great number of branches in the poſterior part of the capſule of the lens, like radii from a centre, as Zinn has deſcribed. He aſſerts that the lens receives its veſſels from the inveſture of the membrana hyoloidea, and that they run back from the edge of the lens towards the poſterior convexity.

extre-

extremities of the arteries into the veins has miſled them.

I am at a loſs to conceive what notions Profeſſor Walter can have entertained regarding this vein diſtributed in the retina, without an accompanying artery. It is a ſuppoſition contrary to the general frame of the œconomy, and I would oppoſe to it, with confidence, my own experience, ſince, in the ox and other animals, I have ſeen the veins of the retina turged with blood and exceedingly diſtinct; yet when I injected the trunk of the artery at the root of the optic nerve, I found a ſet of veſſels injected on the ſurface of the retina quite diſtinct from the turgid veins, and which could be no other than the arteries diſtributed to the retina. I muſt conclude that there is no peculiarity in the diſtribution of veſſels in the tunica vaſculoſa retinæ.

We frequently obſerve, that the trunks of veins and arteries, deſtined to the ſame final diſtribution, take a different courſe; but in their final diſtribution, I know no inſtance in which they do not ramify with parallel branches interwoven with each other.

The VENA CENTRALIS RETINÆ, as it is deſcribed by Haller, is ſometimes a branch of the ophthalmica cerebralis, but often it riſes from the cavernous ſinus, amongſt the origins of the external and inferior recti muſcles of the eye; after giving off many ſmall twigs to the perioſteum and fat of the orbit, it paſſes obliquely from behind, forward, and inward, perforates the ſheath of the optic nerve, and, after ſupplying the ſheath, dips into the ſurface of the nerve.—It is now the comes arteriæ centralis retinæ. It enters through the cribriform plate of the optic nerve, and ſpreading generally in large and remarkable branches on the retina, theſe make free inoſculations with each other, and finally inoſculate with the veins of the ciliary proceſſes.

Whether a branch of the vena centralis retinæ is ſent off to accompany the branch of the artery which takes its courſe through the vitreous humor, I have not been able to determine.

CHAP. IX.

OF THE VASCULARITY OF THE PELLUCID MEMBRANES.

IF we cut through the ſclerotic and choroid coat, round the optic nerve as it enters the eye, and afterwards cut up the outer coats towards the cornea, the humors fall out from theſe coats, and will remain ſuſpended in a fluid, hanging by the optic nerve and cloſely embraced by the retina: we have now to review theſe parts taken collectively, independent of the outward and proper coats, and, as I have claſſed them, as conſtituting the internal globe of the eye.

The firſt peculiarity which ſtrikes us here is the perfect tranſparency of all the parts within the embrace of the retina. As there are, in the adult and healthy eye, no veſſels to be ſeen in the tranſparent membrane and humors, it becomes a queſtion, whether nature has provided for the ſupport and nouriſhment of thoſe parts by other means than the common circulation of red blood through veſſels? Now, I am inclined to think, that there is no ſuch circulation through them; and I believe, that this would be much more generally allowed were there not ſomething like a proof remaining in men's minds that theſe humors and tunics were ſupplied with red blood in the fœtus; whence they deduce the natural conſequence that, in the adult ſtate, theſe veſſels are only ſhrunk ſo as to convey only colourleſs fluids. I have, therefore, to give my reaſons why I think that theſe veſſels of the fœtus are not ſubſervient to the humors; and, I think, I ſhall prove that, when they have once diſappeared, they are no longer pervious veſſels; that, though thoſe parts which they are ſuppoſed to ſupply, ſhould become inflamed and vaſcular in the adult, theſe veſſels which were apparent in the fœtus do not become enlarged; that

that they do not adminifter in any way to inflammation and difeafe, but that a new fource is given, and that veffels are formed which were at no former period difcernable.

Why fhould there be red blood tranfmitted to the pellucid membranes and humors of the fœtus? Why is not that ftate of circulation, which nourifhes and fupports the parts in the adult ftate, fufficient for their growth and the progrefs to perfection which they undergo in the fœtus? Why is the capfule of the lens only crowded with veffels carrying red blood, while the proof of veffels paffing to the cells of the vitreous coat ftands upon fome very rare and vague affertions, and fuch as can be naturally explained by the appearance of thofe veffels which merely pafs through the vitreous humor for a different deftination?

I believe this is a view which has been little attended to; but, upon the moft minute enquiry, and upon examining the preparations of the vafcularity of the eye of the fœtus, I can fee no veffels paffing into the humors and carrying red blood, which are not finally diftributed to the membrana pupillaris. When we lay open the eye of a fœtus, after a very minute and fuccefsful injection, we fee veffels which all proceed from the centre of the optic nerve, paffing through the vitreous humor to the back of the capfule of the lens, viz. the branches of the arteria centralis retinæ. This artery divides very often into many branches before it arrives at the capfule of the lens: now, if thefe be filled with blood, or but partially injected, they have the appearance of being branches diftributed to the vitreous humor, and not to the lens. This appearance is ftill more apt to deceive us when the lens is feparated from the vitreous humor, and when the vitreoous humor is otherwife difturbed, for then the veffels fhrink and feem to terminate in the midft of the vitreous humor. When the injection is perfect there is no fuch appearance.

On the back of the lens we fee a profufion of veffels; but I think I may pofitively fay that thefe veffels do not

 penetrate

penetrate to the lens itſelf, but are merely on the capſule, and that having made the circuit of the lens, they terminate in the membrana pupillaris and ciliary body. I can obſerve no villi on the inner ſurface of the capſule of the lens, nor any appearance of its being a ſecreting ſurface, to lead me to ſuppoſe that theſe veſſels ſecrete the lens, as Walter ſuppoſes they do; nor, after the moſt ſucceſsful injection of the capſule of the lens and of the coats of the eye in general, can I obſerve the ſlighteſt ſtain of colour in the pellucid ſtate of the lens, nor betwixt its white fibres when it becomes opaque. Nor have I obſerved, at any time, a ſingle branch of theſe veſſels, which are ſo profuſe on the back of the lens, diſtributed to the anterior part of the capſule; on the contrary, they all terminate abruptly at that line, a little forward from the utmoſt verge of the lens, where they are united to the veſſels of the membrana pupillaris and ciliary proceſſes. Were theſe veſſels of the capſule provided for the ſecretion of the lens, or were thoſe veſſels the trunks of leſſer branches, which pierce into the ſubſtance of the lens, they would appear alſo on the fore part of the capſule.

If I am accurate in theſe obſervations, we are authorized to deduce this concluſion: — that theſe veſſels which we ſee running through the vitreous humor and capſule of the lens, and which are ſometimes ſeen filled with red blood or injected with ſize and vermillion, are not the veſſels of the humors, but veſſels in their paſſage to the membrana pupillaris, and that they diſappear totally when that membrane is abſorbed. They are injected when the membrana pupillaris is injected; they are more difficult to fill when that membrane is becoming pellucid and tender towards the latter period of geſtation; and with the annihilation of the membrane follows the diſappearance of the veſſels carrying red blood through the tranſparent humor of the eye.

In confirmation of the total annihilation of theſe central veſſels of the vitreous humor, I have found that, when diſeaſe comes upon the lens of the adult, the veſſels,

veſſels, which are apparent in conſequence of inflammation, do not proceed through the old tract from the centre of the optic nerve and through the vitreous humor to the lens, but that they come from the extremity of the retina and laterally, and thence ſpread over the back of the lens.

An eye, which I had lately an opportunity of examining, confirmed me in this opinion. I aſſiſted my brother in an operation on the eye, in which, the anterior part being diſeaſed, it was cut away. I had ſoon an opportunity of retiring and examining the parts with Dr. Monro. I obſerved then an opaque ſpot on the poſterior ſurface of the lens, which was, indeed, in the capſule, and to this ſpot there came veſſels over the margin of the lens from the extremities of the veſſels of the retina; but, in the vitreous humor, there were no veſſels to be ſeen, nor any branches paſſing into the lens obliquely from behind, as they do in the fœtus.

CHAP. X.

SOME SURGICAL OBSERVATIONS CONNECTED WITH THE ANATOMY OF THE HUMORS.

I HAVE already mentioned, as the principle of the operation of extracting the lens, that the ſimple action of the muſcles, ſurrounding the eye-ball, is ſufficient to protrude the lens, if the inciſion of the cornea be of proper dimenſions relative to the ſize of the lens. No doubt, if there have been thickening inflammation and perhaps preternatural adheſions of the membranes ſurrounding the lens, the operation will neceſſarily become more complicated; the lens will not glide at once over the cheek when the inciſion of the corner is completed. But ſtill, I think, we are not to allow ourſelves

to

to confider it as a ftep of the operation, in any circumftances, that the ball of the eye is to be preffed; becaufe, in that cafe, the membranes of the lens give way fuddenly, and part of the vitreous humor unavoidably is protruded with it, or the edge of the lens is turned obliquely to the pupil, and the vitreous humour efcapes by the fide of it. It is better to deftroy the adhefions with the inftrument, and to fcratch the capfule of the lens fo that it may burft. Whence it is evident that it is neceffary, in order to infure the correct performance of the operation of extraction, that the lens fhould prefs equally forward on the pupil, and that the pupil fhould be allowed to dilate. From this it appears, how loofe the ideas of thofe are who can fpeak of trying firft to couch, and if that is not found to fucceed, then to perform the operation of extraction. I conceive the attempt with the needle to preclude the operation of extracting, for thefe reafons: — An unfuccessful attempt to deprefs will, in general, be a laboured and reiterated motion of the point of the needle, which muft occafion inflammation and an adhefion firmer than is natural. Again, in couching, the lens is removed from the axis of the eye fo far only that, in the cafe of the extracting being attempted, it no longer equally oppofes itfelf to the pupil, the confequence of which muft be, the efcape of the vitreous humour and the detenfion of the lens.

In regard to the place at which the couching needle is to be introduced, we may obferve, that we are directed, by the older furgeons, to pierce the fclerotic coat very near to the edge of the cornea, becaufe they were afraid of hurting the lens with the needle! The idea then entertained was, that the cataract was a membrane hung behind the pupil and before the lens. The older furgeons had the idea that the needle entered before the lens, and paffed at once into the aqueous humor. We are to difregard thefe injunctions of furgeons who directed the needle to be introduced with the idea of avoiding the lens; for, while their notions regarding the difeafe were erroneous, their rules of operating could not be correct; accordingly, we find them differing

fering in their directions as to the place of piercing the cornea; some directing us to pierce it at the distance of one line from the edge of the cornea, others at the distance of four lines and a half.

Now that we know the place of the cataract, and know also that it is the opaque lens, we can be at no loss to introduce the needle correctly. If, says M. Petit, we pierce the sclerotic coat one line from the edge of the cornea, we pierce the tunica conjunctiva, sclerotica, choroid, vitreous humor, and ciliary processes before the needle enters the cataract. In this puncture, we wound the most vascular part, and, indeed, every delicate part of the eye; for even in this most anterior course, the retina is equally lacerated with the others*. But if we pierce the sclerotic coat, three lines from the edge of the cornea, we avoid the ciliary ligament and body, and processes; and, by directing it a little forward, in a line towards the opposite margin of the iris, we shall find the point of the needle advancing through the opaque lens; for, although the lens be so far opaque as to prevent the light from striking the retina, it is so far transparent, in general, that the needle is distinctly seen entering its substance, and can be then directed, so as to transfix the cataract without hurting the iris.

We have seen that there is no posterior chamber of the aqueous humour fit to contain the depressed crystalline lens. The belief, which even some modern surgeons have entertained, of the possibility of depressing the lens into the aqueous humor, is a remnant of those inaccurate notions respecting the size of the posterior chamber of the aqueous humor and the place of the lens, which have long been corrected. With this, also, I think ought to have been forgotten, the idea of the rising of the lens after it has been depressed by the cataract floating in the humors.—The fact I am confident

* In our most modern system of surgery, we are directed to enter the needle one tenth of an inch. To my certain knowledge, not only the ciliary body has been injured by this direction, but even the root of the iris has been seen to be pushed forward on the point of the needle.

is this: when, after transfixing the cataract, we endeavour to dislodge it by depressing the point of the needle, we separate the adhesion between the humors and the points of the ciliary processes; we do not, however, unsocket the lens from the fore part of the vitreous humor, but when the lens descends with the point of the needle, from before the pupil, the vitreous humor revolves with it; the consequence of which is, that when the needle is withdrawn, the lens rolls round with the vitreous humor: but as the lens only is opaque, as its firm connexion with the vitreous humor, and even the rolling of the vitreous humor itself cannot be seen, this rolling of the lens appears to be the consequence merely of its own buoyancy in the aqueous humor. This adhesion of the lens to the vitreous humor, I have been sensible of during its depression, from the elastic nature of the resistance which I felt. When the lens parts from its socket in the vitreous humor and when it is depressed with such a turn of the needle as puts it under the anterior part of the vitreous humor, it cannot rise again; there is no motion of the eye which can replace it—there is no aqueous fluid in which, if it were of less specific gravity, it could rise: it lies under and, in part, imbedded in the vitreous humor. Another idea is, that it rises with the needle: but no one, who understands what is to be done in the operation of the needle, will raise it again opposite to the pupil after the lens is depressed — it ought to be withdrawn without again elevating the point. But what has always appeared to me as the most unaccountable cause that can be assigned for the rising of the cataract, is the action of the muscles of the eye*. It has been explained how the lens is protruded by the action of the muscles when the cornea is cut and the aqueous humor let out, for then the uniform resistance of the eye is broken, and there is a motion of the humors towards the breach, and the lens, lying behind the pupil, is the first part to be protruded forward; but when it lies under the an-

* See Mr. Benjamin Bell's System of Surgery.

terior

terior part of the vitreous humor (and there it muſt lie if it is at all diſplaced), or in whatever ſituation it happens to be, from that it cannot be moved by the action of the recti muſcles; for they embrace the eye on every ſide, and their action operates uniformly, ſo that they cannot effect a body immerſed in the midſt of the humors. For the ſame reaſon that we ſhould decline the operation of extracting, after attempts have been made to depreſs with the needle, I ſhould refuſe when the pupil is rugged and irregular, becauſe the diſeaſe may be more extenſive than it appears to be. Thus cataracts brought on by falls, or blows, or punctures of the eye, are leſs favourable, as there is danger of the inflammation having gone deep, and having affected the other humors in a way which cannot be known, ſince the opaque lens is betwixt us and them.

A frequent cauſe of the failure of the operation of depreſſion is the diſplacement of the lens backwards; for when it ſeems to have gone down with the needle, it has ſlipped from under it and ſtarted backward. In this caſe the pupil appears clear, but the patient gains little advantage; for the cataract, though removed from the pupil, is ſtill in the ſituation to obſtruct the light.

CHAP. XI.

OF THE MANNER IN WHICH THE EYE ADAPTS ITSELF TO THE DISTANCE OF OBJECTS.

THIS is a queſtion which many have endeavoured to determine, and many have failed; the proof of this is, that there is not *one* explanation of the manner in which the eye adapts itſelf to the diſtance of objects, but *many* explanations equally ingenious.

One opinion is, that the eye is at reſt when we ſee the

the diſtant parts of a landſcape, but that the direction of the eye to the nearer objects is attended with an effort. This effort is the action of the ſtraight muſcles of the eye compreſſing the ball of the eye, ſo as to lengthen the axis as much as is neceſſary to allow the pencils of rays to unite in points upon the retina.

To this opinion it is objected, that in ſome animals the ſclerotic is hard, and not capable of changing its figure; that in man, the preſſure would be unequal; that the unelaſtic retina would be thrown into irregular folds; that theſe muſcles, being voluntary muſcles under the will, we ſhould be more conſcious of their operation than we are; and that, while the mind remains attentive to diſtant objects, no voluntary exertion of theſe muſcles can effect the diſtinctneſs of the objects. Again, to make the eye change its accommodation from the diſtinct viſion of objects, at ſix inches to fourteen feet five inches, would require ſuch a preſſure as might lengthen the axis of the eye one-tenth part, which again would form an oval that would derange the retina.

Another opinion is, that when the eye ſees the neareſt objects it is at reſt, and that, in attending to diſtant objects, the ſtraight muſcles draw back the fore part of the eye into the ſocket, and thus ſhorten the axis. To this opinion, of courſe, the ſame objections lie as to the ſuppoſition that the axis is lengthened by the operation of the muſcles.

There are ſome who have entertained an opinion, that the iris, by its contraction, operates ſo on the circular margin of the cornea, where it is connected with the ſclerotic coat, as to make the cornea more convex, and thus encreaſe its power of concentrating the rays and enable the eye to ſee near objects diſtinctly. To account for this power in the iris, Dr. Jurin, the propoſer of this hypotheſis, ſuppoſes that there is a greater muſcular ring in the margin of the iris connected with the edge of the cornea; the exiſtence of theſe muſcular fibres is not demonſtrated, but he ſays, ſince the leſſer muſcular ring in the inner margin of the iris is not

 proved

proved by occular inſpection, and yet is juſtly inferred from its effects, viz. the contraction of the pupil; in the ſame way, "the change of conformation in the eye has not yet been adequately accounted for, but may be fairly made out by ſuppoſing the exiſtence of the greater muſcular ring." His concluſion is in theſe words:—
"When we view objects nearer than the diſtance of
"15 or 16 inches, I ſuppoſe the greater muſcular ring
"of the iris contracts, and thereby reduces the cornea
"to a great convexity; and when we ceaſe to view
"theſe near objects, this muſcular ring ceaſes to act,
"and the cornea, by its ſpring, returns to its uſual
"convexity ſuited to 15 or 16 inches. In which con-
"dition the elaſticity of the cornea on the one ſide,
"and the tone of the muſcular ring on the other,
"may be conſidered as two antagoniſts in a perfect
"equilibrium."

To this opinion it is objected, that the iris is not rooted in the cornea, but in the ſclerotic coat, which is firm in man and inflexible in many animals. We have alſo to conſider, that this delicate and inviſible circle of muſcular fibres has not only to contract the margin of the cornea, but, in this action, to alter the configuration of the whole eye. The eye-ball is a whole equally diſtended, and no part of it can ſuffer contraction without a reſiſtance from the whole of the coats: beſides, in this caſe, the alternation of light and the brightneſs of objects would be perpetually obſcuring the image, by the play of the iris cauſing an alteration of the focus of the cornea. But Dr. Jurin did not attribute the whole effect to the action of the iris. He thus explains the uſe of the fluid ſurrounding the lens and the membranous capſule:—When the eye is to be ſuited to greater diſtances, he ſuppoſed that the ligamentum ciliare contracts its longitudinal fibres, and, by that means, draws the part of the interior ſurface of the capſule, into which theſe fibres are inſerted, a little forward and outward. By this action, he ſuppoſed that the fluid, within the capſule of the lens, flows from the middle towards the margin; and, conſequently, the centre

centre of the capſule of the lens is reduced to a leſs degree of convexity; and that the elaſticity of the capſule, and the tone of the ligament, may be looked upon as two antagoniſts perfectly in equilibrio with one another. In the ſtate of reſt, the eye is conceived, by Dr. Jurin, to be adapted to the middle diſtance; by the encreaſe of the convexity of the cornea, to be adapted to nearer viſion; and by the change in the capſule of the lens, to be fitted to diſtant objects.

To this laſt ſuppoſition it is objected, that there is a ſimplicity in the operations of nature; that the change, wrought upon the capſule of the lens, is inſufficient to account for the whole effect, and that, therefore, there is a preſumption that it has no ſhare in producing the change; that there are no muſcular fibres in the ciliary proceſſes; and, laſtly, that this fluid, being of denſity but little, if at all, removed from the aqueous humor, any alteration of its form can have but a very inſignificant effect.

It has occurred to others*, that the oblique muſcles of the eye-ball, being thrown in oppoſite directions round it, they may have the effect of elongating the axis of the eye: Again, that the action of the orbicularis muſcle of the eye-lids, by compreſſing the eye-ball, aſſiſts in accommodating the eye for ſeeing near objects more diſtinctly. Dr. Monro makes a ſet of experiments to prove the effect of the orbicularis muſcle of the eye-lids; but I conceive that he has deceived himſelf, in aſcribing to the compreſſion of the eye-lids an effect partly produced by a voluntary effort, but in a way which is not underſtood, and partly by the contraction and dilatation of the pupil, from the degree of opening of the eye-lids. If he be right in his way of accounting for the effects produced in the experiments which he details, they ought to have the effect of precluding the neceſſity of all further hypotheſis; ſo fully does the action of the orbicularis muſcle ſeem to him adapted to the end propoſed. In the firſt experiment, when he

* Hambergerus, Briggs, Keil, Monro.

opened

opened his eye lids wide, and endeavoured to read a book, the letters on which were ſo near the eye as to be indiſtinct, he found that he could not do it. In the ſecond experiment, keeping the head in the ſame relation to the book, he brought the edges of the eyelids within a quarter of an inch of each other, and then made an exertion to read, when he found he could ſee the letters and words diſtinctly. When I try this experiment I find the action of the eye-lids to have no ſenſible effect, unleſs they are brought very cloſe together: then I do indeed find that they have a moſt remarkable effect. But in this ſituation, the eye-lids cover the cornea ſo much, that if they have any effect at all upon the cornea, it muſt be to compreſs and flatten it, and not to give it a greater convexity. The ſmaller the opening of the eye-lids, the greater I found the effect, I conceive it to be produced by the optical effect of the eye-laſhes correcting the two great converging of the rays; and the ſame effect I found to be produced by the marginal hairs of two flat camel-hair bruſhes, although the eye lids were kept open. Dr. Monro concludes that, in this action of the eye 1ſt, the iris, 2dly, the recti muſcles, 3dly, the two oblique muſcles, and, 4thly, the orbicularis palpebrarum, have all their ſhare in accommodating it to the diſtance of objects, and in giving perfect viſion.

Very ingenious experiments are made by Dr. Young*, to determine whether there be any change in the length of the axis of the eye-ball. He conſiders it as neceſſary to account for the power of the eye in adapting it to the diſtance of objects, that the diameter ſhould be enlarged one-ſeventh: its tranſverſe diameter diminiſhed one-fourteenth; and the ſemi-diameter ſhortened one-thirtieth of an inch. To determine this he fixed the eye, and at the ſame time he forced in upon the ball of the eye the ring of a key, ſo as to cauſe a phantom

* Philoſ. Trans. for 1810.

very accurately defined to extend within the field of perfect viſion; then looking to bodies at different diſtances, he expected, if the figure of the eye was altered that the ſpot, cauſed by the preſſure, would be altered in ſhape and dimenſions; he expected that, inſtead of an increaſe of the length of the eye's axis, the oval ſpot cauſed by the preſſure of the key, reſiſting this elongation, ſhould have ſpread over a ſpace at leaſt ten times as large as the moſt ſenſible part of the retina: but no ſuch effect took place; the power of accommodation was as extenſive as ever, and there was no perceptible change either in the ſize or in the figure of the oval ſpot. Again, he placed two candles ſo as exactly to anſwer to the extent of the termination of the optic nerve; he marked accurately the point to which the eye was directed; he then made the utmoſt change in its focal length, expecting that, if there were any elongation of the axis, the external candle would appear to recede outward upon the viſible ſpace; but this did not happen; the apparent place of the obſcure part was preciſely the ſame as before.

A favourite opinion of late has been, that the lens has a power of altering its degree of convexity, and thus accommodating itſelf to the diſtance of objects. As to the fibrous ſtructure of the lens, there can be no doubt: firſt it is rent by fiſſure, then ſplit into lamina, and can be finally teaſed out into fibres.

This ſtructure was firſt obſerved by Leewenhoeck; he has theſe words:—" Porro vidi corpus criſtallinum " ex tam tenuibus concervatis conſtare ſquamis ut ubi " eas oculo dimetior, dicere cogar, pluris bis millenis " ſibi invicem incumbere; ubi enim corpus criſtallinum ab ejus membranula ſeperaſſem, ejus adhuc " axis, ubi craſſiſſimum erat, (non enim eſt perfecte " rotundum, ſed aliquo modo planum) duas tertias " pollicis partes retinebat; ergo a centro ad circumferentiam eſt tertia pollicis pars atque quoniam, ex " dimenſione mea 600 pili lati pollicis quadrati, longitudinem conficiunt 200 pili lati pollicis tertiam " partem

" partem adæquare debent. Atque nunc video ubi " denæ ſquamæ ſunt coacervatæ, eas capilli noſtri " diametrum nondum adæquare; ergo his 10 cum " 200 multiplicatis, ſequetur, ut dictum, plures 2000 " ſquamas in corpore criſtallino eſſe coacervatas. Porro " vidi ſingulas has ſquamas ex filamentis, concinno " ordine juxta ſe poſitis, conſtare adeo ut ſingulæ " ſquamulæ unum filamentum ſint craſſæ; & ut hanc " ſubſtantiam fibros eam ex qua corpus criſtallinum " conſtat ob oculos ponerem, eam, lineis in circulum " ductis quantum pote deſignavi."

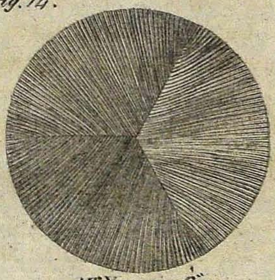
The fibrous ſtructure and muſcularity of the lens was brought forward by Deſcartes, as explaining ſome actions of the eye; but was again neglected, till more lately, that it has been revived by the inſertion of Mr. Young's obſervations on viſion in the Philoſophical Tranſactions *. The following are Mr. Young's obſervations on the appearance of the lens:—" The criſ-" talline lens of the ox is an orbicular convex tranſ-" parent body, compoſed of a conſiderable number " of ſimilar coats, of which the exterior cloſely adheres " to the interior. Each of theſe coats conſiſts of ſix " muſcles, intermixed with a gelatinous ſubſtance, " and attached to ſix membranous tendons. Three " of the tendons are anterior, three poſterior; their " length is about two thirds of the ſemidiameter of " the coat; their arrangement is that of three equal " and equidiſtant rays, meeting in the axis of the criſ-" talline; one of the anterior is directed towards the " outer angle of the eye, and one of the poſterior to-" wards the inner angle, ſo that the poſterior are " placed oppoſite to the middle of the interſtices of " the anterior; and planes paſſing through each of " the ſix and through the axis, would mark on either " ſurface ſix regular equidiſtant rays. The muſcular " fibres ariſe from both ſides of each tendon; they " diverge till they reach the greateſt circumference of

* See vol. for 1793.

"the coat and having passed it they again converge "till they are attached respectively to the sides of the "nearest tendons of the opposite surface. The an-"terior or posterior portion of the six viewed to-"gether, exhibits the appearance of three penniforme-"radiated muscles. The anterior tendons of all the "coats are situated in the same planes, and the pos-"terior ones in the continuations of these planes be-"yond the axis. Such an arrangement of fibres can "be accounted for on no other supposition than that "of muscularity. The mass is inclosed in a strong "membranous capsule, to which it is loosely connected "by minute vessels and nerves; and the connection is "more observable near its greatest circumference. "Between the mass and its capsule is found a con-"siderable quantity of an aqueous fluid, the liquid "of the cristalline."

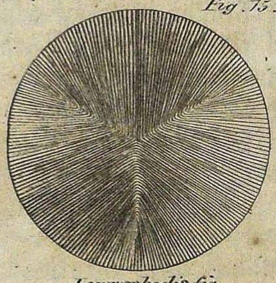
Fibrous Structure of the Lens

Fig. 14.



Mr. Young's fig.

Fig. 15.



Leeuwenhoek's fig.

Supposing that these are muscular fibres, from their closeness and direction, they would stand acknowledged as forming the strongest and most powerful muscle of its size in the whole body; yet they act only on themselves, which requires the least possible degree of power. Again, how are they relaxed? What power is their antagonist?

antagoniſt? Mr. Young demonſtrates not only the muſcular fibres, but the tendons of the lens *; as if it were not evident that the lens acted merely on itſelf, which could require no concentrating of its fibres into tendons; for tendons are found in other parts of the body only where it is neceſſary to concentrate the whole power of the muſcle ſo as to operate on one point.

We learn from Mr. Home †, that Mr John Hunter had proved the lens to be laminated, and thoſe laminæ to be compoſed of fibres; and upon the ſame authority, we learn that his opinion was in favour of the muſcularity of its ſtructure. Mr. Home wiſhed to follow out this ſubject, by including it in the Croonian Lecture. Mr. Home found, with the aſſiſtance of Mr. Ramſden, that a patient, after the extraction of the cataract, ſtill retained the power of adapting the eye to the diſtances of objects. Indeed, we muſt be well aware that if a patient, after couching and extracting the lens could only ſee at one giving diſtance, an effect ſo very particular muſt have been long ſince obſerved This was a conviction to Mr. Home and Mr. Ramſden, that the inveſtigation was to be no further purſued in this tract, and they turned their attention, therefore, to the cornea.

Mr. Ramſden contrived an apparatus which, if the gentlemen engaged in the experiments have not deceived themſelves, muſt put this queſtion at reſt. By Mr. Ramſden's ingenious contrivance, the head was fixed accurately, and at the ſame time a microſcope was adapted to obſerve the changes in the convexity of the cornea as the eye was directed alternately to near and to diſtant objects. In theſe experiments, the motion of the cornea became diſtinct, its ſurface remained in a line with a wire which croſſed the glaſs of the microſcope when the eye was adjuſted to the diſtant objects, but projected conſiderably beyond it when adapted to the near ones, and the ſpace through

* See Philoſ. Tranſ. † Ibid.

which it moved was ſo great as readily to be meaſured by magnifying the diviſions on the ſcale, and comparing them. In this way it was eſtimated that it moved the 830 part of an inch (a ſpace diſtinctly ſeen in a microſcope magnifiying 30 times), in the change from the neareſt point of diſtinct viſion to the diſtance of 90 feet.

In the evidence from anatomical ſtructure, I cannot think Mr. Home ſo happy. He was deſirous of determining more accurately than had hitherto been done, the preciſe inſertion of the tendons of the four ſtraight muſcles, ſo as to know whether their action could be extended to the cornea or not: he found them to approach within $\frac{1}{8}$ of the cornea before their tendons became attached to the ſclerotic coat. But he did not ſtop here—he ſtripped off with them the anterior lamina of the cornea. Now, as it is ſuppoſed, in theſe experiments, that the action of the recti muſcles upon the ſides and back part of the ball compreſſes the humors, and makes them flow forward ſo as to diſtend the cornea; if the extremities of the tendons be inſerted into the edge of the cornea and even paſs over it, as Mr. Home has demonſtrated, their effect would be to flatten the cornea, by drawing out and extending its margin. This is a circumſtance which Dr. Munro has remarked; and Dr. Munro has alſo, with more accuracy of obſervation, found "all the tendinous fibres of the recti muſcles firmly attached to the ſclerotic coat at the diſtance of a quarter of an inch from the cornea, and no appearance that any part of them, or that any membrane produced by them, is continued over the cornea."

Amongſt the variety of opinions, the innumerable, ingenious, but contradictory experiments for diſcovering the manner in which the eye adapts itſelf to the diſtance of objects, I am, for my own part, much at a loſs to determine which I ſhould prefer. I have often doubted whether theſe experimenters were not in ſearch of the explanation of an effect which has no exiſtence.

existence. I have never been able to determine, why a very slight degree of convexity in the cornea of a short-sighted eye should be so permanent during a whole lifetime, notwithstanding the perfect elasticity of the cornea, and its being so adapted as to alter its convexity by the action of the muscles. Again, a near-sighted person, with the assistance of a concave glass, can command the objects to the distance of some miles, and with the glass still held to his eye, can see minute objects within three inches of the eye. Now I cannot conceive how the concave glass should give so great a range to the sight: as there can be no change in the glass, it must be the eye which adapts itself to the variety of distances; yet, without the glass, it cannot command the perfect vision of objects for a few feet. Again a short sighted person sees an object distinctly at three inches distant from the eye; at 12 feet, less distinctly; and when he looks upon the object at 12 feet, the objects beyond it are confused, just as in other men's eyes; but when he directs his attention to the more remote objects, those nearer become indistinct. Now this indistinctness of the object, seen when he examines narrowly the objects beyond them, would argue (did we admit this muscular power in the eye of adapting itself to objects), that the cornea or the lens has become less convex, were we not previously convinced that the utmost powers of the eye could not bring the object at the distance of 12 feet, or any other intermediate distance, to be more distinctly seen than the fixed and permanent constitution of the eye admits.

I cannot help concluding, therefore, that the mechanism of the eye has not so great a power of adapting the eye to various distances as is generally imagined, and that much of the effect attributed to mechanical power is the consequence of attention merely. An object looked upon, if not attended to, conveys no sensation to the mind. If one eye is weaker than the other, the object of the stronger eye, alone is attended to, and the other is entirely neglected: if we look through a glass with

with one eye, the viſion with the other is not attended to. Now objects, as they recede from us, become fainter and fainter in their colours, and the general effect upon the eye is different from thoſe which are near; and as it happens that the mind muſt aſſociate with the ſenſation before it be perfect, there is, conſequently, an obſcurity thrown over diſtant objects when we contemplate near ones; as, on the other hand, the images of near ones are not attended to when the mind is occupied with diſtant ones, although they be nearly in the line with the diſtant object examined.

CHAP. XII.

OF SEEING IN GENERAL.

THE eye is certainly the nobleſt of the organs of ſenſe. It is that with which we ſhould part the moſt unwillingly, and of which, when deprived, we are moſt helpleſs. A celebrated philoſopher ſays, how much more noble is that faculty by which we can find our way in the pathleſs ocean, traverſe the globe, determine its figure and dimenſions, delineate every region of it; by which we can meaſure the planetary orbs, and make diſcoveries in the ſphere of the fixed ſtars! Again, how admirable is that organ by which we can perceive the temper and diſpoſitions, the paſſions and affections of our fellow creatures; and, when the tongue is taught moſt artfully to lie and diſſemble, the hypocriſy is diſcovered in the countenance! we often are able to detect what is crooked in the mind as well as in the body! Yet, notwithſtanding the perfection of the ſenſe of ſeeing, much of this perfection is gained by the other ſenſes, and particularly by that of touch. If the human body were motionleſs and inert, the

ſenſa-

ſenſation conveyed by the eye would be very imperfect; we ſhould be able to conceive neither the diſtance nor the figure of objects. But, as it is, the diſtance of the object, joined with its viſible magnitude, is the ſign of its real magnitude; and the diſtance of the ſeveral parts of an object, joined with its viſible figure, becomes a ſign of its real figure. Without this combination of the original ſenſation with the acquired perception, we ſhould ſee form and colour without having any idea of its diſtance, or of the convexity of an object; we ſhould have no meaſure of its length, or breadth, or diſtance.

Upon other occaſions, we are apt enough to acknowledge the powers of aſſociation. But the connection of ideas is in no inſtance more conſtant and ſecret than in the ideas conveyed by ſight and touch. When a ſolid body is preſented to view, we ſee only the light and ſhade; but this raiſes in our mind the aſſociated ideas from the ſenſe of touch, viz. ſolidity, convexity, and angularity, "the viſible idea exciting "in us thoſe tangiable ideas," which, in the free and promiſcuous exerciſe of our ſenſes, uſually accompany it. It is thus that we attribute to the ſenſe of ſight what is the act of the memory and judgment *.

We have ſeen that the picture of an object is formed in the bottom of the eye. It was formerly ſufficient to ſay, that the mind contemplates this image. We ſhould ſay now, that this image is conveyed into the ſenſorium by the optic nerve. This is an hypotheſis merely; and we have no more conſciouſneſs of the object being in the brain or ſenſorium than in any other part of the body: we may rather ſay, that the impreſſion made on the organ, nerves, and brain, is followed by ſenſation, and that the intelligence is the joint operation of the whole †. Laſtly, the metaphyſician calls our

* See Dr. Jurin on Mr. Molyneux's problem, Smith's Append. p. 27.

† Euclid, and others of the ancients, contended that viſion was occaſioned by the emiſſion of rays from the eye to the object. He thought

our ſenſations the ſigns of external objects; becauſe the object itſelf is not preſented to the mind, nor is there an actual reſemblance betwixt the object and the ſenſation of it, but merely a connection eſtabliſhed by nature, as certain features are natural ſigns of anger; or by art, as articulate ſounds are the ſigns of our thoughts and purpoſes.

We are now naturally led to the conſideration of ſome points, the full comprehenſion of which, require the knowledge, both of anatomy and of the principles of optics.

PARALLEL MOTION OF THE EYES.

The axis of the eye is a line drawn through the middle of the pupil and of the criſtalline lens, and which conſequently falls upon the middle of the retina; and the axis of both eyes produced, are called the optic axis. But the axis of the eyes, it is evident, are not always parallel; for when both eyes are directed to a near object, the axis of the eyes meet in that object; but when we direct the eyes to the objects in the heavens, they may be conſidered as perfectly parallel in their axis, though perhaps not then mathematically ſo. To an obſerver, the eyes ſeem always moving in parallel directions; but nature has given us the power of varying them ſo, that we can direct them to the ſame point, whether remote or near. This, however, is in ſome meaſure learnt by cuſtom, and loſt by diſuſe. A child has much difficulty in altering the diſtance of

thought it more natural to ſuppoſe, that an animate ſubſtance gave out an emanation, than that the inanimate body did. In 1560, the opinion was confirmed that the rays entered the eye.—The ſenſation was not always believed to be in the retina: it was by ſome believed that part of the ſenſation was to be attributed to the criſtalline. Kepler, in 1600, ſhewed, geometrically, how the rays were refracted through all the humors of the eye, ſo as to form a diſtinct picture on the retina; and alſo he ſhowed the effect of glaſſes on the eyes. See further, regarding the opinions of the ancients, Boerhaave Prelect. Acad. tom. iv. p. 282.

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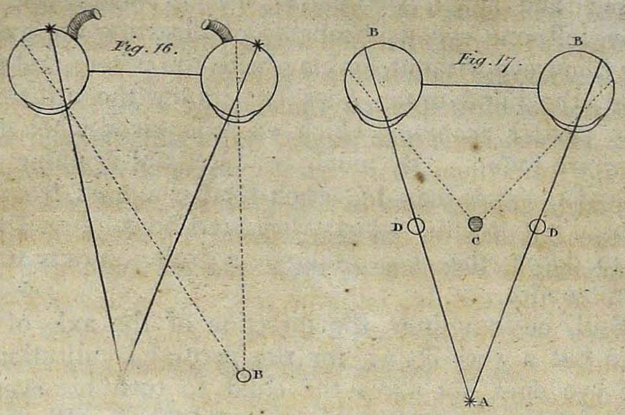
its eyes, which is the occaſion of the vacancy of its ſtare: and again, we obſerve that a patient who has long loſt one eye, is incapable of directing the axis of the blind eye without looking with the other, and even then, the blind organ does not follow the other with that perfect accuracy which exerciſe gives when both eyes are ſound. By much practice and ſtraining, the axis of the eyes may be much further altered from the natural paralleliſm, which wags and boys often do, ſo as to diſtort the eyes, and give a droll obliquity to the countenance.

Still, cuſtom alters the direction of the axis of the eyes but a very little; for the natural conſtitution of the eye does not allow the child to turn his eyes in every different direction from each other. There is, on the contrary, as we have ſeen, a particular ſenſible ſpot in the retina, which makes it neceſſary to diſtinct viſion, that this ſpot ſhall receive the concentrating rays of light; and the natural conſtitution of both eyes, is, that this ſpot in each eye ſhall have ſuch a relation to that of the other, that the axis of both ſhould be accurately in the middle of the eye-ball in order to produce ſingle viſion.

By voluntary ſquinting or depreſſing one of the eyes with the finger, objects appear double, becauſe the optic axis is changed in the diſtorted or depreſſed eye, and the picture is no longer painted on correſponding points of both. This ſimple experiment leads us to conſider what is the conſtitution and correſpondence of the eyes, that, when each has the picture of the object impreſſed upon it, we ſhould only ſee it ſingle if the eyes are ſound and perfect.



For example, the object A, in fig. 16., is exactly in the centre of the axis of both eyes, consequently, it is distinctly seen: and it appears single, because the rays from it strike upon the points of the retina opposite to the pupils in both eyes. Those points have a correspondence; and the object, instead of appearing double, is only strengthened, in the liveliness of the image. Again, the object B will be seen fainter, but single, and correct in every respect. It will appear fainter, because there is only one spot in each eye which possesses the degree of sensibility necessary to perfect vision: and it will appear single, the rays proceeding from it having exactly the same relation to the centre of the retina in both eyes. Though they do not fall on the centre of the retina, they fall on the same side of the centre in both eyes. But if the eyes are made to fix stedfastly on an object, and if another object should be placed before the eyes within the angle which the axis of the two eyes make with the first object, it will be seen double, because the points of the retina struck by the rays proceeding from the nearer object do not correspond in their relation to the central point of the retina. Thus, the eyes B B, fig. 17., having their axis directed

directed to A, will see the object C double somewhere near the outline D D. Because the line of the direction of the rays from that body C, do not strike the retina in the same relation to the axis A B in both eyes. Upon this principle, we may easily explain why objects, which are much nearer the eyes, or much more distant from them than that to which the two eyes are directed, appear double. Thus, if a candle is placed at the distance of ten feet, and I hold my finger at arms length between my eyes and the candle, when I look at the candle, I see my finger double, and when I look at my finger, I see the candle double. This double vision occurs to us all frequently; but, unless we make the experiment purposely, we do not attend to it. Many other instances of the harmony, and of the want of it in the eyes, particularly the reverse of what these diagrams shew, may be easily produced, viz. the seeing two objects single: for, if we look at a halfpenny and a shilling, placed each at the extremity of two tubes, one exactly in the axis of one eye, and the other, in the axis of the other eye, we shall see but one piece of coin, and of a colour neither like the shilling nor like the halfpenny, but intermediate, as if the one were spread over the other.

This relation and sympathy between the corresponding points of the two eyes, is, therefore, to be considered as a general fact, viz. that pictures of objects falling upon corresponding points of the two retinas, present the same appearance to the mind as if they had both fallen upon the same point of one retina; and pictures upon points of the two retinas which do not correspond, and which proceed from one object, present to the mind the same apparent distance and position of two objects, as if one of those pictures were carried to the point corresponding with it in the other retina.

Several animals, we see, direct their eyes by very different laws from those which govern the motion of ours; but we are not to reason upon their sensations by the laws of vision of the human eyes: we must take

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it as a principle, that nature has been bountiful to them alſo; and that the reſult of organization in their eyes is perfect viſion.

In birds, (if we except the owl,) the eyes diverge, and are directed to oppoſite ſides. As the owl ſeeks his prey in the night, it may be neceſſary to the diſtinctneſs of his viſion in weak light, that both eyes be directed to the object. Moſt fiſhes have their eyes directed laterally, though there are exceptions; as thoſe fiſhes which are flat, and ſwim at the bottom, have their eyes directed upward. In many inſects, the ſurface of the eye has no reſemblance to the cornea of viviparous animals; but when examined with the microſcope, it is ſeen to conſiſt of a number of tubercles, each of which is as a diſtinct eye. In others the eye is removed to the extremity of the moveable tenaculæ. Very large animals, as the whale, elephant, rhinoceros, hippopotamos, have, in proportion to their bodies, very ſmall eyes: ſo have the animals which live much under ground; and, in general, a large eye is a ſign of the animal being able to ſee in obſcure light, becauſe there is proportionably a greater number of rays admitted into the eye. For the ſame reaſon, fiſhes have a pecularly large eye and dilatable pupil, becauſe the water is a more obſcure medium, and, from the occaſional roughneſs of its ſurface, much darkened and variable.

We muſt conclude, that in theſe varieties of the eyes, where there is a difference in number, poſition, and natural motion, there are different laws of viſion adapted to theſe peculiarities and the exigences of the animals. If we are to judge from analogy, we may ſuppoſe, that in many animals, there is no correſpondence between points of the two retinas, or it is of a different kind from ours. In thoſe which have immoveable eyes, the centre of the two retinas will not correſpond ſo as to give the idea of one object, but of diſtinct objects, and in their reſpective places. In other animals, correſponding points would give falſe appearances; and in ſuch as turn their eyes in all di-

 rections,

rections, independently of each other, they would seem to possess a perception of the direction in which they move them, as we have of the motion of our arms.

SQUINTING.

We have seen, that there is a point in both retinas more acutely sensible to the impression of light and the image of objects, than any other part of all its concave surface. In a sound eye, this point is immediately opposite to the pupil. There is a coincidence betwixt this point and the axis of the eye; and when we look to an object, its image strikes this point of the retina: but if it should happen that this sensible point of the retina should be changed, and not be exactly opposite to the pupil when the axis of the eye is in the line with the object, there will be an effort of the muscles moving the eye-ball to turn, so that the rays proceeding from the object shall strike upon the more sensible spot of the nerve*. Again, if the greater sensibility of the nerve should lie in its proper place, and a remote cause should occasion such an action of the muscles and distortion of the eye as we see in a squint, then the image will be double, for it no longer falls on corresponding points of the retina of each eye, and separate images are conveyed to the brain. If, however, this distortion continues, the single vision is gradually restored. Is there, then, in this case produced a new correspondence betwixt points of the retina which were before discordant? We find that this is not the case, by a very simple experiment.—In a person who squints, one of the eyes is directed to the object and the other appears to be turned from it: if the sound eye be shut, and the person be directed to look to an object with the other, it is directed to it

* This was M. de la Hire's opinion.—He had an idea also that squinting was produced by the obliquity of the object. Both of these opinions are refuted by Dr. Jurin.

with

with the proper and natural axis. Now this ſhows us that the ſenſibility of the proper ſpot in the bottom of the eye is not loſt. We muſt explain the ſingle viſion in eyes, one of which is diſtorted from its natural axis, upon another principle. Moſt people who ſquint, have a defect in one eye, and this is the diſtorted eye, while the other is directed in the true axis to the object. Now the mind does not attend eaſily to two impreſſions, the one being weaker than the other: in a ſhort time the weaker impreſſion is entirely neglected, and the ſtronger only is perceived.—So in ſquinting, the impreſſion on the weak eye in a ſhort time ceaſes to be attended to, the ſtrong and vivid impreſſion is alone perceived, and ſingle viſion is the conſequence. It is evident, then, that thoſe who ſquint muſt have a degree of imperfection in the ſtrength of the image; for it is neceſſary to neglect the impreſſion of one eye, to obtain diſtinct viſion with the other; the conſequence of this is frequently an attempt ſtill further to diſtort the eye, and turn it ſo far inward or under the upper eye-lid that no diſtinct impreſſion can be received upon it: at all events, they perceive the object only with one eye, although they may be ſaid to ſee it with both; the perception being the combined operation of the organ and of the mind.

If the ſenſation of one eye be weak, it is very liable to be neglected altogether, and that eye is apt to wander from the true axis; and if the perſon be careleſs, or given to diſtort his eyes in childiſhneſs, a permanent ſquint may be given to the eyes.

Another cauſe of ſquinting, in children, is the being ſo laid in their cradle, that the light ſtrikes obliquely into one of the eyes, whilſt the other cannot ſee it; by which means one of the eyes only comes by degrees to be directed to the light whilſt the ſenſation of the other is diſregarded. What is very extraordinary in ſquinting, is the correſpondence in the muſcles of the eye, notwithſtanding the great diſtortion of the eye-ball; for, when both eyes are open, as the ſound eye turns in all variety of directions to the ſurrounding objects, the

the other eye ſtill follows it, but preſerves its diſtance, ſo as in a manner to avoid all interference. Blows on the head, drinking and ſmoaking, and a variety of irritations, occaſioning convulſions and diſtortion of the eyes, cauſe double viſion. As this is evidently produced by the affection of the muſcles moving the eye ball*, ſince any change upon the retina could not give occaſion to ſuch diſtortions in a ſtate of inſenſibility, we may naturally conclude, that ſquinting is ſometimes the conſequence of irregular action of the muſcles; for if thoſe tranſient cauſes are apt to affect them, ſo will they be apt to be permanently affected†.

We can diſtort our eyes by an unnatural effort, but we cannot ſquint: that is to ſay, we can bring our eyes into ſuch a forced ſituation that we cannot ſee any thing diſtinctly; but we cannot keep one eye diſtinctly upon an object and turn the other from it. — Such a poſition of the eyes, at leaſt (and which is exactly that of thoſe who ſquint unintentionally), I cannot, by any means, accompliſh ‡. This ſhows the ſtrict correſpondence betwixt the moving muſcles of the eye-balls. By

* The command of the voluntary muſcles is firſt loſt in intoxication; and, therefore, it is more likely that the muſcles ſhould loſe their natural action and correſpondence than the retina.

† In Smith's Optics, there is a caſe of ſquinting and double viſion occaſioned by a blow. In Buffon's Diſſertation, in the Acad. Roy. des Sc. 1743, ſquinting after long continued pain of the head. In the Mem. Roy. de l' Acad. des Sc. 1718, Hiſt. p. 29. there is a curious inſtance of falſe viſion. I find alſo quoted ſeveral caſes of ſtrabiſmus from ſudden fright, in *Ephem. Germ. cent.* 3 & 4. *obſ.* 152. *p.* 349. Ib. dec. 3. an. 8 & 11. ob. 57. d. 114. Ib. dec. 3. an. 9 & 10. obſ. 67. "Novi Juvenem paralyſi obnoxium, cui cum cæteris oculi ſiniſtri muſculis relaxatis, *adducens* fortius contraheretur propter oculum ita diſtortum objectum quodcunque duplex apparebat, nec quod verum eſſet diſtinguere poteſt." *Willis de anima Brut. P. Phyſiol.* p. 77. An inſtance of the loſs of correſponding motions of the eyes, and ſtrange illuſions of ſight. See in the Enquiry into the nature of mental derangement by Dr. Crichton, vol. i. p. 147.

‡ It is ſaid that aſtronomers, who are much uſed to attend only to the impreſſions of one eye, are ſometimes able to ſquint at pleaſure. See Mr. Home Phil. Tranſ. 1797. p. 17.

this experiment, we ſhall find the difficulty of that method of correcting the ſquint propoſed by Dr. Jurin, or of commanding motions of the eyes different from thoſe which have been beſtowed by nature, or acquired by habit. But habit I believe to be much more ſeldom the origin of ſquinting than is generally ſuppoſed. It is ſaid, by Dr. Reid and others, that we ſee young people, in their frolics, learn to ſquint, making their eyes either converge or diverge when they will to a very conſiderable degree: Why ſhould it be more difficult for a ſquinting perſon to learn to look ſtraight when he pleaſes? The reaſon of the greater difficulty is obvious, that in making the eyes converge or diverge the will is acting upon both eyes equally; but to diſtort one eye inward or outward, and at the ſame time to keep the other fixed, is to me like an abſolute impoſſibility. Moſt people, who ſquint, have a defect in the diſtorted eye, a weakneſs which they do not obſerve, from want of attention to the impreſſions upon that eye. It will be difficult to determine whether this defect be an original fault, or the effect of the want of uſe; ſince, by tying up the ſound eye, the weak one becomes gradually ſtronger, ſo that the perſon becomes able to read with it, much may be attributed to the neglect of impreſſions.

It may be obſerved, that this neglect of the impreſſions, which are actually received, is not at all like that diſuſe, which is the conſequence of no impreſſion being received: for darkneſs encreaſes the ſenſibility of the retina, while this diſſipates and exhauſts it. That ſquinting is not produced by the weakneſs of the impreſſion received upon the nerve, would appear from the circumſtance that opacity of the humors or the gutta ſerena do not occaſion an alteration of the uſual correſpondence in the muſcles moving the eye-balls.

It is ſaid, that in thoſe who have loſt the ſight of one eye, the habit of directing it to the object they look at is loſt, becauſe this habit is no longer of uſe to them *.

* Dr. Reid.

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This I have never obferved, nor fhould I think it apt to happen, unlefs the mufcles of the eye had been injured from the fame caufe which deftroyed the fight; at any rate, it is in a very imperfect degree, and not fuch as we fhould call a fquint.

In regard to the cure of fquinting, it feems the moft reafonable, in the firft place, to endeavour to ftrengthen the weak eye by ufe, and by tying up the found one. In this cafe, the diftorted eye becomes properly directed to the object, and the ftrength of the impreffion is in fome degree reftored. When this has been perfevered in for fome time, and the perfon is allowed to look at any object with both eyes, the weak eye will perhaps be again diftorted from the true axis; but, probably, with a painful effort and double vifion: which fhows fome progrefs in the recurrence of the two eyes, and their proper fympathy, and that the impreffion on the weak eye is at leaft attended to. After this, it will be time enough, by Dr. Jurin's method, to endeavour to correct the fquint:—"place the child before you, and let him clofe the undiftorted eye, and look at you with the other. When you find the axis of this eye fixed directly upon you, bid him endeavour to keep it in that fituation, and open his other eye. You will now immediately fee the diftorted eye turn away from you towards his nofe, and the axis of the other will be pointed at you. But with patience and repeated trials he will, by degrees, be able to keep his diftorted eye fixed upon you, at leaft for fome little time after the other is opened. And when you have brought him to continue the axis of both eyes fixed upon you, as you ftand directly before him, it will be time to change his pofture, and to fet him firft a little to one fide of you and then to the other, and fo to practife the fame thing; and when, in all thefe fituations, he can perfectly and readily turn the axis of both eyes towards you, the cure is effected. An adult perfon may practife all this with a glafs, without any director, though not fo eafily as with one.—But the older he is the more patience is neceffary. About twenty years ago, I attempted a

cure after this manner, upon a young gentleman about nine years of age, with promising hopes of succefs; but was interrupted by his falling ill of the fmall-pox, of which he died."

Dr. Jurin preferred this method to the ufe of tubes or fhells with fmall holes in them, which have been recommended. But what appears to me the great difficulty, lies in the ftrength of the impreffion received upon the found eye, which, caufing the impreffion of the weak eye to be entirely neglected, it is again thrown out of the line of direct vifion. I conceive it, therefore, to be a neceffary part of the experiment with tubes or fhells, that the vifion through the tube, applied to the found eye, fhall be fo obfcured as to have fome accordance with the leffer fenfibility ofothe weak eye, and then, objects being feen equally with both eyes, a gradual accordance of the mufcles may be produced. The conviction of the neceffity of giving an equality to the ftrength of the fenfation of both eyes muft have ftruck M. de Buffon, fince he fays, in his Differtation in the Academy of Sciences, that a plane glafs fhould be applied to the weak eye and a convex one to the ftrong eye, fo as to reduce the laft to a ftate lefs capable of acting independently of the other.

But what is called a weaknefs, is very frequently, I am convinced, merely a fhort-fightednefs in one eye: what the effect of this fhould be we may experience if we look to an object with both eyes, but with one of them through a concave or convex glafs; if we are looking upon a book, there will be produced a confufion of the letters, but, by a little practice, the letters will become again diftinct. By an attentive obfervation, we fhall find that this is the confequence of attending folely to the impreffion received in the naked eye: nay, what is ftill more ftrange, we can attend, in this experiment, to the impreffion upon the point of the axis of one eye, and to the general impreffion of both. If, while looking upon the letters of a large page, I move the convex glafs of a fmall degree of power fide way before my right eye, the whole letters of the page feem

to

to move, leaving diſtinct and ſtationary a circular ſpot containing a word or two. Here by no effort, while I look with both eyes, can I loſe the ſteady and diſtinct ſight of theſe few words, becauſe their image is received upon the more ſenſible central point of the retina of my left eye: but all the other part of the ſphere of viſion I can ſee alternately, dimmed or diſtinct, as I chuſe to attend to the leſs powerful impreſſion of the right eye, or the natural ſenſation of the left. We ſee by this experiment, how eaſy it is to neglect the impreſſion of one eye, if it be no ſtronger than that of the other (and of courſe more eaſily if it be weaker), and how impoſſible it is to neglect the more vivid impreſſion.

From ſuch a radical defect in the viſion, as the humors of one eye having a different focus from the other, and conſequently an indiſtinctneſs of viſion produced from two images of different ſizes intermingling their colours, children ſeem very frequently to be made to ſquint; and I have known adults, with a degree of the ſame inequality in the eyes, kept from ſquinting only by a particular attention to the direction of their eyes. M. de Buffon, in his Diſſertation already quoted, after affirming what has been already delivered, viz. that no one ſquints with both eyes at once, ſays, he has obſerved three inſtances in which the eyes, according to circumſtances, were alternately diſtorted from the object. This he accounts for by finding that, with one eye, the letters of a book could be ſeen at the diſtance of two or three feet, and not nearer than fifteen inches; while, with the other, the letters could be diſtinguiſhed at the diſtance of from four to fifteen inches only. Conſequently, when looking to diſtant objects, the image being more diſtinct with the long-ſighted eye, the other was turned from the object; but when objects at a ſmall diſtance were ſeen, the image in the far-ſighted eye being imperfect, it is turned from the axis, that it may not interfere with the ſtronger image of the other eye, which is now directed to the object.

A frequent effect of the weakneſs left by long fevers in children, is a ſquint which gradually goes off as the ſtrength is reſtored. It is obſerved, alſo, that ſquinting and double viſion are, in ſome fevers, a concomitant with delirium and phrenitis. This ſymptom proceeds, in all likelihood, from an unequal tenſion of the muſcles of the eye-ball. The double viſion is the effect of diſcordance in the action of the muſcles.

CHAP. XIII.

OF THE EYE-LIDS, OF THEIR GLANDS, AND OF THE COURSE OF THE TEARS.

Having completed the deſcription of the eye, as the organ of viſion, we have now to attend to its connections, its adventitious membranes, the glands of the eye-lids, and the courſe of the tears. It is plainly neceſſary that the eye ſhould not be looſe in the ſocket; but that, in its rolling motion, it ſhould ſtill be attached; and that, although the delicate anterior ſurface muſt be expoſed, the internal parts of the ſocket ſhould be defended from the intruſion of extraneous bodies. This is accompliſhed by the tunica conjunctiva.

The TUNICA CONJUNCTIVA, or ADNATA, is the inflection of the common ſkin of the eye-lids. It goes a little back into the orbit, and is again reflected, ſo as to come forward and cover the forepart of the eye-ball. Here it is pellucid, and the white coat of the eye ſhines through it. It covers the cornea alſo; and here it is perfectly tranſparent; looſes its character of vaſcularity, as the conjunctiva; and is aſſimulated to the nature of the cornea. As this coat is a continuation of the common integuments, it is, like them, vaſcular, and liable to inflammation. The tunica conjunctiva, is the common ſeat of ophthalmia. In the

the commencing inflammation, we ſee the veſſels turgid or blood ſhot: by and bye, they elongate towards the ſurface of the cornea; the patient complains of dimneſs; the dimneſs becomes apparent to the ſurgeon; ſpots of opacity then form in the cornea; and the veſſels of the conjunctiva now take a courſe over the turpid ſurface of the cornea. In this ſtage of the inflammation, by cutting the turgid veſſels of the conjunctiva, we interrupt the ſource of blood for a time, and procure a ſmall evacuation; but theſe veſſels ſoon coaleſce again, and the flow of blood is renewed.

The TUNICA ALBUGINEA is the thin tendinous coat formed by the inſertion of the recti muſcles, which expand over the anterior part of the eye. I would admit this into the enumeration of the coats of the eye, merely to prevent confuſion of names, and to make intelligible the deſcriptions of ſome of the older writers. It is not properly a coat. Where the conjunctiva covers the anterior part of the eye, the white ſclerotic coat is ſeen under it; and in conſequence of this, the tunica conjunctiva is ſometimes called albuginea.

A very material part of the ſtructure of the eye ſtill remains to be deſcribed; an apparatus by which the ſurface of the eye is preſerved from injury, kept moiſt, and perfectly tranſparent.

The EYE-LIDS are compoſed of the common integuments, with this difference only, that they have a cartilaginous margin to give them ſhape, and muſcular fibres, in the duplicature of their membrane, to give them motion. A ſmall ſemilunar cartilage, which lies like a hoop in their edge, keeps them of a regular figure, and ſo as to cloſe neatly over the eye. This cartilage having a triangular edge, and the baſe of the angle forming the flat ſurface of the margin of the eye-lid, they meet with the moſt perfect accuracy. Either end of this hoop-like cartilage is connected with the perioſteum at the corners of the eye, ſo as to move with its fellow as upon a hinge. This cartilage of the eye-lid is called TARSUS.

The upper eye-lid only, is moved for the admiſſion of light to the eye; it is raiſed by the levator palpebræ muſcle. But the eye-lids are ſhut again by the orbicularis palpebrarum, which acts on both eye-lids, and ſometimes with ſuch power, as to ſqueeze the eye-ball even to a painful degree.

The MEIBOMEAN GLANDS. Theſe are very elegant little glands which lie under the inner membrane of the eye-lids. About twenty or thirty ducts of theſe glands open upon the tarſus of each eye-lid. Theſe ducts run up under the vaſcular membrane of the inſide of the eye-lids, and minute glandular folicules, to the amount of about twenty, are, as it were, attached to each of theſe ducts. Theſe glands exude a white ſebaceous matter, which defends the edge of the eye-lid from the acrid tears, and cloſes them more accurately by its unctuoſity. The vaſcularity of the inner ſurface of the eye-lid is ſubſervient to theſe glands; for the veſſels forming their ramifications round the little glands, ſecrete the ſebaceous matter into them. This, then, is the ſeat of the ophthalmia tarſi; and following this inflammation, the edges of the eye-lids, and the mouths of the ducts, are ſometimes eroded with little ulcers. Theſe ducts are the ſeat of the ſtye. This is an inflammation and cloſing up of the mouth of one of the ducts, which then ſwells up into a little hard granule in the edge of the eye-lid, accompanied with inflammation of its cyſt or ſurrounding membrane.

OF THE SECRETION AND COURSE OF THE TEARS.

THE LACHRYMAL GLAND is ſeated in the upper and outer part of the orbit, and behind the ſuperciliary ridge of the frontal bone. It is of a flattened form, and is depreſſed into a hollow of the bone. Several ducts from this gland open upon the inner ſurface of the upper eye-lid. By the reflection of the membrana conjunctiva from the eye-lid over the ſurface of the eye-ball, duſt and motes are prevented from getting behind the eye-ball; and when they have got under the eye-lids, the extreme ſenſibility of the tunica conjunctiva

junctiva excites the lachrymal gland, and the orbicular muscle of the eye-lids, (which, by its pressure, accelerates the flow of the tears,) and the dust or motes are washed out. The puncta for reabsorbing the tears and conveying them into the nose, being at the inner angle or canthus of the eye-lids, we see the intention of the ducts of the lachrymal gland opening on the inside of the upper eye-lid towards the outer angle: for, by this means, the tears are spread over all the surface of the eye-ball, by the motion of the eye-lids, before they decline into the puncta. But the tears do not flow only when the gland is excited by motes; their secretion is perpetual, and, together with the motion of the eye-lids, they perpetually moisten the surface of the eye-ball. Even during sleep they flow continually; and here we may admire a provision for their conveyance towards the inner canthus, in the inclination of the tarsus to each other; for the eye-lids meet only on the outer edge of the broad surface formed by the tarsus, the consequence of which is, that a kind of gutter is formed in the angle by the inner edges of the tarsus not meeting, which leads the tears from the ducts of the lachrymal gland towards the puncta lachrymalia.

The PUNCTA LACHRYMALIA are the mouths of two ducts which form the beginning of a canal for drawing off the tears from the eye into the nose. These puncta are placed at the inner canthus of the eye, and on the termination of the tarsus of the upper and under eye-lid: they are surrounded by a rigid substance; and their patent mouths absorb by capillary attraction. They lead the tears into the lachrymal sac, and thence the tears pass into the nose.

The CARUNCULA LACHRYMALIS is that little granulating-like body which lies in the inner angle formed by the two eye-lids. Very small hairs are seen to sprout from it, and some small sebaceous folicles open upon its surface. Connected with the caruncula lachrymalis is the MEMBRANA or VALVULA SEMILUNARIS. This is a vascular membrane which is drawn from under

under the caruncula lachrymalis by the direction of the eye outward, so as then to appear like a web spread over the white of the eye near the inner canthus. By directing the eye towards the nose, this membrane is again accumulated about the caruncula. This, then, is a very particular mechanism, not as is generally described, for applying the tears to the puncta lachrymalia, but for accumulating and throwing out the motes and dust from the eye, and for guarding the puncta from the absorption of such little particles as might irritate or obstruct them.

In birds, the valvula semilunaris is drawn, by a muscle and small tendon inserted into it, quite across the eye, so as to act like a third eye-lid; it is in them called membrana nictitans.

The LACHRYMAL SAC and DUCT lie in the os unguis or lachrymale. The sacculus is a bag of an oblong or oval figure; it is sunk into the fossa of the os unguis, and defended by the frontal process of the superior maxillary bone; and it is covered by the ligamentous connection of the orbicularis muscle. This sac is the dilated upper end of the nasal duct; and into it the two canaliculi lachrymales (the extremities of which are the puncta), open as distinct tubes*.

Two coats are described as covering the lachrymal sac; a nervous, white, external coat; and a vascular, pulpy, pituitary membrane. This sac diminishing towards the lower part, and being received into the complete canal of the bone, becomes the nasal duct. Taking a course downward and backward, it opens into the nose under the inferior spongy bone. The lachrymal sac and duct are by some conceived to be muscular, so as to enable them to convey the tears into the nose; or it may be conceived, that they act like a syphon, the duct reaching down into the nose acting like the long leg of the syphon, and drawing the tears in at the openings of the puncta. But I think it would appear, that the connections of the orbicularis muscle over

* Dr. Monro.

the

the ſac is of a nature to accelerate the paſſage of the tears, and even perfectly to compreſs the ſac. The lachrymal ſac and duct are very frequently diſeaſed and obſtructed. For example, after ſmall-pox, ſiphylis, or in ſcrophulous conſtitutions, the inner membrane of the ſac being of the nature of the pituitary membrane of the noſe, inflames, ſwells, and adheres. The conſequences of this are, firſt, a ſwelling of the lachrymal ſac in the inner angle of the eye, and a watery or weeping eye; upon preſſing the tumor, the tears, mixed with mucus, are forced back through the puncta; by and by the ſac inflames and ſuppurates; matter is diſcharged by preſſure of the ſac: and, laſtly, it is eroded and burſts out, diſcharging the tears and matter on the cheek. This is the complete character of the fiſtula lachrymalis. While the ſac burſts outwardly, it often does further miſchief within, by making carious the thin lamina of bone in which it lies. The theory of the ancients, with regard to this diſeaſe, was that the diſeaſe was proceeding from the caries of the os unguis, and they perforated with the actual cautery, until the patients ſmelt it in the noſe! as much with the intention of remedying the caries as to give paſſage to the tears. But it is not the bone which is the obſtruction to the perfect cure of this diſeaſe by operation, but the membranes, which cloſe again after the moſt ingenious attempts to preſerve the paſſage. The vis medicatrix, in this inſtance, ſeems not to be ſo well aware of her intereſt as ſome phyſiologiſts would inculcate. She is, here, ever at variance with the artifice of the ſurgeon.

BOOK II.

OF THE EAR.

CHAP. I.

OF THE SOUND, AND OF THE EAR IN GENERAL.

THE ear is that organ by which we are made ſuſceptible of the impreſſion of ſound.

Sound is the effect of impreſſion on the auditory nerve, by which correſponding change is produced in the brain; or we ſay ſound is a vibratory motion of bodies depending upon their elaſticity or tenſion. It may be produced by the vibration and motion of the air, but not without the intervention of ſolids. The human voice, for example, does not depend merely on the percuſſion of the air, but on that vibration, as combined with the tenſion and conſequent vibration of the glottis, excited by the current of air; which, again, is modified by the mouth. The ſcience of ſound as producing melody and harmony is a very intereſting and curious one, for by the ſucceſſion of ſounds or notes, and their conſonance, there is a language for which words are no ſubſtitute.

There is no body impervious to ſound, or, in other words, incapable of tranſmitting the vibration. That ſound is communicated through the medium of the air, we know from the circumſtance, that a bell, when ſtruck in a vacuum, gives out no ſound: and again, from this, that the condenſed ſtate of the atmoſphere affords an eaſier communication of ſound, and conveys it to a greater diſtance. The velocity of the impreſſion

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tranſmitted by the common air, is computed at 1130 feet in a ſecond; and ſound, when obſtructed in its direct motion, is reflected with a velocity equal to that with which it ſtrikes the ſolid body by which its progreſs is interrupted.

That water conveys the vibrations producing ſound, has been proved by experiment. It was once the ſaying of naturaliſts, that, to ſuppoſe fiſhes to have the organ of hearing, would be to conceive that an organ were beſtowed upon them without a poſſibility of its being of uſe. But we are aſſured of the fact, that, on the tinkling of a bell, fiſhes come to be fed*; and it was the cuſtom for the fiſhermen on the coaſt of Britany, to force the fiſh into their nets by the beating of drums †, as our iſlanders are at preſent accuſtomed to do when the larger fiſh get entangled amongſt the rocks. We are told, that in China, they uſe a gong for the ſame purpoſe. Theſe facts were once of importance, though more accurate obſervation has now made them ſuperfluous. The Abbé Nollet took much pains to decide the queſtion, whether water was a medium for ſound. After conſiderable preparation, and acquiring a dexterous management of himſelf in the water, (for which he takes great merit to himſelf,) he found that he could hear under water the ſound of the human voice, and even diſtinguiſh converſation and muſic. The human ear being an organ imperfectly adapted to this medium of ſound, theſe experiments do

* Boyle.

† M. l'Abbé Nollet, Acad. R. des Sciences. Naturaliſts were very incredulous of the effect ſaid to be produced by muſic on lobſters. Some may be ſo ſtill; but we may truſt the following obſervation of Minaſius, in his Diſſertation. "*Su de timpanelti dell udito* "*ſcoperti nel Granchio Paguro.*" "Propriis obſervationibus certior "factus aſſerit, obſcura nocte, placidoque mari, quoties piſcatores "ardentibus ſaculis paguri in littore hærentis oculos lucis fulgore "perſtringunt, ut ſtupido, et pene præſtigiato animale potiantur, ſi "forte rumor aliquis ingruit. CANCRUM illico ſe e littore ſubducere recipereque intra undas." See *Scarpa Diſquiſitiones Anatomicæ* de Auditu in Inſectis, &c.

not

not inform us of the relative powers of air and water in the tranfmiffion of found. But another experiment of the Abbé Nollet proves, what indeed to me is fufficiently evident, from the ftructure of the ear of fifhes, viz. that the water tranfmits a much ftronger vibration than the air. When he funk under water and ftruck together two ftones which he held in his hands, it gave a fhock to his ear which was infupportable, and which was felt on all the furface of his body, like that fenfation which is produced when a folid body held in the teeth is ftruck by another folid body *. He obferved in other experiments, that the more fonorous the bodies ftruck were, the lefs vivid was the impreffion; by which it would appear, that water, though it conveys an impreffion more ftrongly to the ear than the air, is not equally adapted to the refonance and variety of tone. Indeed, this is a natural confequence of the water, a fluid of greater denfity being in clofe contact with the founding body, and fuppreffing its vibration. In thefe facts, we fhall find the explanation of fome peculiarities in the ftructure of the ears of fifhes.

Thus, we fee, that the vibration of a folid body is continued through the air and through water, until reaching the organ of hearing it, it produces the fenfation of found. Sound, it will be evident, is alfo communicated through folids. When we put the ear to one end of a log of wood of thirty feet in length, and ftrike upon the other, we are fenfible of the impreffion; and when a folid body applied to the bones of the head, or to the teeth, is ftruck, we are fenfible of the noife †; and this is felt even by thofe who are deaf to impreffions conveyed through the air: indeed it is partly in this way that we are to judge whether deafnefs may be cured by operation, as depending upon fome injury of the mechanifm of the organ, or whether it be an incurable affection of the nerve or brain itfelf. If the found be perceptible when conveyed through the

* Thefe experiments were repeated by Dr. Monro. See his Book of Fifhes.

† Perhaps we cannot call this found.

teeth,

teeth, or when a watch, for example, is preſſed upon the bone behind the outer ear, we are aſſured that the internal organ is unaffected; and upon enquiring farther into the caſe, we may find that the deafneſs proceeds from ſome diſeaſe of the outer tube of the ear, or of that tube which leads into the throat, and that it can be remedied.

CHAP. II.

GENERAL VIEW OF THE VARIETIES IN THE EARS OF ANIMALS *.

THERE is in the ſcale of animals a regular gradation in the perfection of the organ of hearing. But, in the human ear, we find united all the variety of apparatus for communciating the vibration to the internal organ, and along with this the moſt extenſive diſtribution of nerves in the labyrinth, or inmoſt diviſion of the ear, to receive that impreſſion.

The ultimate cauſe of this more complex ſtructure is the greater power with which man is endowed of receiving through the ear, various impreſſions of ſimple ſounds: language, muſic, and various modifications of the ſenſe, of which the lower animals are probably incapable.

As, in treating of the anatomy of the eye, we do not attempt to inveſtigate the manner in which light acts upon the retina, in producing the ſenſation of colours, but endeavour merely to explain the ſtructure of the eye; to ſhow how the coats ſupport and nouriſh the humors; how the humors are ſubſervient to the concentration of the rays of light, and aſſiſt their impulſe

* In the following ſhort account of the comparative anatomy of the ear, although I have taken every aſſiſtance in my power from books, I have deſcribed the ſtructure, in all the examples, from my own diſſections and obſervation.

upon

upon the retina: ſo, in the ſame manner, in explaining the ſtructure of the ear, we need not inveſtigate the philoſophy of ſound, nor the nature of thoſe impreſſions which are made by it on the ſenſorium through the nerves; our views are limited to the ſtructure of the ear—we have to obſerve the mechaniſm by which the ſtrength of vibrations is increaſed and conveyed inward to the ſeat of the ſenſe, and the manner in which the nerve is expanded to receive ſo delicate an impreſſion.

The method of ſtudying this ſubject, which is at once the moſt inſtructive and the moſt amuſing, is to trace the various gradations in the perfection of the organ, through the ſeveral claſſes of animals. It is chiefly by comparing the ſtructure of the viſcera, and the organs of ſenſe in animals and in man, that comparative anatomy is uſeful in elucidating the animal œconomy. For example, in the ſtigmata and air-veſſels of inſects and worms; in the gills of fiſhes; in the ſimple cellular ſtructure of the lungs of amphibiæ; in the more complicated ſtructure of the lungs of birds; we obſerve one eſſential requiſite through the whole gradation, viz. the expoſure of the circulating fluids to the action of the air. And in this variety of conformation, we ſee the ſame effect ſo modified as to correſpond with the habits and neceſſities of the ſeveral claſſes of animals. In the ſame manner, with regard to the circulating ſyſtem, we are taught the explanation of the double heart in the human body, by tracing the variety of ſtructure through the ſeveral claſſes of animals; from the ſimple tube circulating the fluids of inſects, the ſingle ventricle of fiſhes and reptiles, the double auricle and perforated ventricle of amphibiæ, up to the perfect heart of the warm blooded animal. The organs of generation, and the œconomy of the fœtus in utero, is, in the ſame degree, capable of illuſtration from comparative anatomy. But moſt eſpecially, in the ſtructure of the ear, is there much ſcope for this kind of inveſtigation. We find ſuch varieties in the ear of reptiles, fiſhes, birds, and quadrupeds

drupeds as lead us, by gradual ſteps, from the ſimpler to the more complex ſtructure.

The ſimpleſt form of the organ of hearing is that in which we find a little ſac of fluid, and on the inſide of the ſac the pulp of a nerve expanded. If an animal having ſuch an organ, breath the air, a membrane cloſes this ſaculus on the fore part; and, by means of this membrane, the vibrations of the air are communicated to the expanſion of the nerve through the fluid of the ſac. But if the animal inhabits the water only, it has no ſuch membrane to receive the impreſſion; the organ is incaſed in bone or cartilage, and inſtead of the membrane, ſome ſmall bone or hard concreted matter is found in contact with the pulp of the nerve. The ſound, paſſing through the waters, is, in ſuch caſe, conveyed to the organ not by any particular opening, but through the bones of the head; and this concrete ſubſtance, partaking of the tremulous motion, communicates the ſenſation to the nerve *.

For example, in the CRAB and LOBSTER, we find a prominent bony papilla or ſhell, which is perforated with a membrane extended acroſs the perforation, and behind this membrane there is a fluid, in which the nerve is expanded, and which receives the impulſe conveyed to the membrane. In the CUTTLE-FISH, again, there is no external opening; there is merely a little ſac under the thick integuments: this ſac has in it a ſmall concretion or bone for receiving the vibration; which, in this animal, is conveyed by a more general impreſſion upon the head than in thoſe laſt mentioned; and the vibration of this looſely poiſed bone or concrete ſeems equal to the proviſion of the membrane which, in the crab, cloſes up the external opening in the perforated ſhell.

In FISHES, there is a conſiderable variety of ſtructure. Thoſe which remain perpetually under water,

* It is conceived by ſome that the antennæ of inſects conveys to them the vibration of bodies, and that they may be conſidered as an imperfect variety of this organ.

have not the outer membrane, nor any apparatus for ſtrengthening the firſt-received undulations of ſound. But ſuch as lie baſking on the ſurface of the water, and breathe through lungs, have an external opening — a canal leading to the membrane, and behind the membrane bones to convey the vibration to the internal parts, and theſe internal parts, the ſeat of the ſenſe, are actually as perfect as in terreſtrial animals.

In neither of the ſpecies of fiſhes, the cartilaginous nor ſpinous fiſhes, is there a proper external opening, as in animals breathing air. They receive the impulſe from the water, upon the integuments and bones of the head; but within the head, and in the ſeat of the ſenſe, they have a moſt beautiful apparatus for receiving and conveying thoſe general vibrations to the expanded nerve. There is in every ear, adapted to hearing under water, a bone or concretion, placed ſo as to vaccilate eaſily, and which is deſtined to agitate the fluid in which it is ſuſpended with a ſtronger vibration than could be produced merely by a general impulſe. Beſides this proviſion in fiſhes, there is a very elegant ſtructure for ſtill further encreaſing the ſurface deſtined to receive the impulſe, and for expoſing to that impulſe or vibration a larger proportion of the expanded nerve. It conſiſts of three ſemicircular tubes, which penetrate widely within the bones of the head. They are filled with a fluid, and have in their extremities a diviſion of the nerve which is moved or otherwiſe affected by the vibration of the fluids contained within the tubes.

There is a ſlight variety, however, in the ear of cartilaginous fiſhes. In the head of the SKATE, for example, there is under the ſkin, at the back of the head, a membrane extended acroſs a pretty regular opening. This, however, is not conſidered as the opening of the ear; but a paſſage, like a mucous duct, which is beſide it, has given occaſion to a controverſy between Profeſſors Scarpa and Monro; and it may not be out of place to enquire a little into this diſputed point.

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We have ſeen that water conveys the ſound of vibrating bodies with a ſhock almoſt intolerable to the ear, and with a particular and diſtinct ſenſation over the whole body. We ſee, alſo, that, in the greater number of fiſhes, there is confeſſedly no external opening, the whole organ is placed under the ſquamous bones of the head. Yet the cartilaginous fiſhes, which are ſuppoſed to have an external ear, ſwim in the ſame element, and are in no eſſential point peculiar in their habits. And we ſhould receive with caution the account of any peculiarity in the organ of hearing of one claſs of fiſhes, which is not common to all inhabiting the ſame fluid. Such animals as occaſionally paſs from the water into the air, muſt have a membrane capable of vibrating in the air; but, even in them, it is expanded under the common integuments, and protected by them. Were it otherwiſe, when the creature plunged into the water, it would be aſſailed with that noiſe (confounding all regular ſounds), of which man is ſenſible when he plunges under water. It appears oppoſite to the general law of nature, to ſuppoſe any ſpecies of fiſh having that ſimple and more delicate membrane which is evidently intended to convey atmoſpheric ſounds only, while, on the other hand, creatures living in the water alone, ſhould have an organization fit to endure the ſtronger vibrations of their denſer fluid, and which would be uſeleſs and abſurd in thoſe exiſting in our atmoſphere.

When we come to examine the ear of the ſkate we find, that what Dr. Monro conceives to be the OUTWARD ear of the fiſh *, is really, as repreſented

* "In the upper and back part of the head of a ſkate, and in a "large fiſh weighing 150 pounds, at the diſtance nearly of one inch "from the articulation of the head, with the firſt vertebra of the "neck or atlas, two orifices, capable of admitting ſmall ſized ſtocking wires at the diſtance of about an inch and a quarter from each "other, ſurrounded with a firm membranous ring, may be obſerved. Theſe are the beginnings of the Meatus Auditorii Externi." Treatiſe on the Ear, p. 208.

 by

by Dr. Scarpa, a mucous duct merely *; which does not lead into the sacculi of the vestibule and semicircular canals, as appeared to Dr. Monro; and that to suppose this would be to acknowledge the free access of air and water to the immediate seat of the organ, and to the soft pulp of the auditory nerve, a thing absurd in every view, impossible in nature, and very wide of the truth †. To me it appears, that this narrow duct cannot be considered as the external ear; because we find in the skate a proper membrane under the thin integuments, quite unconnected with the duct, for transmitting the sound; and, upon following this mucous duct, we find it taking a circuitous course, and filled with a strong gelatinous matter; it is every where narrow, and filled with a glutinous secretion. It has no membrane stretched across it, and bears no resemblance to the external ear of any other animal.

We may conclude, then, that fishes have no external opening like terrestrial animals; that, instead of this outward provision, they have the moveable bone within the organ. Although the cartilaginous fishes have a membrane extended over part of the organ, which, in the spinous fishes is completely surrounded with bone, it is not to be considered as capable of the tremulous motions of the membrana tympani of terrestrial animals, but may be considered as analogous to the membrana fenestræ ovalis: and, since it lies deep under the integuments, we have no reason to believe that sound is transmitted to the organ of hearing in fishes, any otherways than through the general vibration of the head.

* Dr. Scarpa, speaking of this opinion of Dr. Monro, says, "qua in re vehementer sibi hallucinatus est, ostia nimirum ductuum "mucosorum, ut manifestum est, pro auris meatubus accipiens. "Etenim omnino nullum est in cartilagineis piscibus ostium auditus "extus adapertum, membranaque *fenestræ ovalis* sub communi in- "tegumento recondita jacet et cooperta."

† "Quod et absurdum est et a rei veritate quam maxime alie- "num," Vid. *Anatomicæ Disquisitiones de auditu et olfactu, auctore* A. Scarpa.

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The organ of hearing in amphibious animals, demonſtrates to us a difference in the manner in which the ſenſation is received; for they have both the outer membrane to receive the vibration of the air, and a mechaniſm of ſmall bones to convey this motion into the ſeat cf the ſenſe; and they have, beſides, within the ear itſelf, a chalky concretion; a proviſion plainly intended for propagating the motion comunicated through the water.

In ſerpents, birds, and quadrupeds, we ſhall hereafter trace the various gradations in the perfection of this organ. We ſhall find, that, as the animal riſes in the ſcale, the cavities and tubes of the ear are extended and varied in their form. Now, I conceive that, while the multiplied forms of the tubes and ſphericles of the internal ear afford a more expanded and ſuſceptible ſurface for receiving impreſſions, the conſonant forms of the parts enable them to receive a ſtronger vibration, and a more perfect and modified ſound.

A cord of a muſical inſtrument will vibrate when another in exact uniſon with it is ſtruck. The vibration communicated to the air is ſuch as is adapted to the tenſion of the ſymphoonic cord; and no other percuſſion of the air, however violent, will cauſe it to ſound. Again, the air paſſing through a tube of certain dimenſions, will not communicate to it a motion, nor call forth its ſound, while the air, paſſing in equal quantity through a tube of one degree of difference, will riſe into a full note. What holds true in regard to the uniſon of cords, is alſo true of cylinders, or even of the walls of a paſſage or room, a certain note will cauſe the reſonance of the paſſage or room, as a certain vibration will call forth the ſound of the tube of an organ; becauſe it is in all theſe inſtances neceſſary that the impulſe be adapted to the poſition of the ſurfaces and their powers of reverberation.

Theſe few facts illuſtrate what I mean, by ſaying, that the various forms of the internal ear of animals, as they advance in the ſcale, give additional powers to their

their organ. In the firſt example of the ſimple ear, where a bone vibrates on the expanded nerve, I ſhould conceive that the ſenſation were in conſequence of this ſimple percuſſion, capable of little variety; but in animals where, beſides this ſimpler mechaniſm there are ſemicircular canals, and more eſpecially in thoſe animals, which have ſtill a further complication of the forms of the ear, certain ſounds will be peculiarly felt in each of theſe ſeveral cavities and convolutions; and while the ſenſation is becoming more diſtinct, by the perfection of the organ, it admits alſo, of a greater variety of ſounds or notes: ſo that a certain ſtate of vibration will affect the ſemicircular canals, (one or all of them,) and produce the ſenſation of ſound, which would not at all affect the vibration of the ſimple lapillæ lying in their ſac.

CHAP. III.

DESCRIPTION OF THE ORGAN OF HEARING IN PARTICULAR ANIMALS.

IN THE LOBSTER AND CRAB.

In theſe animals, the ſtructure of the ear is very ſimple; but it appears to me that Profeſſor Scarpa, in his deſcription, has imagined the organ to be more ſimple than it is in nature.

In the LOBSTER, there projects from near the root of the great antenna, an oſſeous papilla of a peculiarly hard and friable nature. In the point of this papilla we obſerve a foramen, and a membrane ſtretched over it This is the ſeat of the organ of hearing It is deſcribed as containing a ſac of a pellucid fluid, which adheres to the membrane, while the auditory nerve is expanded upon

upon the lower ſurface of the ſac. Now, the lobſter, being an animal which can live on land as well as in water, Scarpa gives this as an inſtance of a ſtructure calculated to receive the ſenſation of ſound equally well from the water or from the atmoſphere. But, from the figure I have given of the ear of this creature, it will not appear to be ſo exceedingly ſimple; while there is evidently a proviſion for the reception of the vibration communicated through the water, though it does not indeed ſtrictly reſemble that which is commonly found in the ears of fiſhes. There is ſuſpended behind the ſacculus, and in contact with the nerve, a ſmall triangular bone, which when pulled away *, is found to hinge upon a delicate cartilage. This bone ſeems evidently intended, by its being thus ſuſpended in the neighbourhood of the PULP OF THE auditory nerve, for impreſſing upon that nerve the vibration from the water. The lobſter, then, has like the amphibious animals, a double proviſion for receiving the communication of ſound alternately from the water or from the air †.

The ear of the CRAB differs from that of the lobſter in this, that, under the projection, there is a moveable caſe of bone, to which we ſee a ſmall antennæ attached Within this is the organ of hearing; and there is here an internal proviſion for the tranſmiſſion of ſound to the auditory nerve, which conſiſts ſimply in a few circumgyrations of a pellucid and flexible cartilage: an inſpiſſated fluid ſurrounds this gyrous cartilage, while the pale auditory nerve is expanded behind it.

OF THE EAR OF FISHES. In the heads of fiſhes, there is a cavity ſeparated by a thin vaſcular membrane from that which contains the brain. Within this cavity there is a ſacculus diſtended with a fluid, and containing a ſmall bone ‡; on the inſide of this bag, (which is called the ſacculus lapillorum), a great pro-

* See fig. 2.

† From the mucous-like tranſparency of the nerve in the lobſter, it is difficult to aſcertain its exact relation to this bone.

‡ See plate, fig. 3.

portion of the auditory nerve is expanded. In the cartilaginous fiſhes, there are three lapilli * contained in their proper capſules, and ſurrounded with a gelatinous matter †, each of the lapilli having its appropriated diviſion of the acauſtic or auditory nerve diſtributed upon it in a beautiful network.

This cavity in the head of fiſhes, reſembles the centre of the labyrinth in the human ear, and is called the veſtibule. Within the veſtibule there is a limpid fluid, interſected every where by a delicate and tranſparent cellular membrane; and the parts within the veſtibule are ſupported in their place by this tiſſue, which is ſimilar to that which ſupports the brain in fiſhes.

Beſides this central part of the organ in fiſhes, there are departing from the veſtibule three ſemicircular cartilaginous canals ‡, within which, are extended membranous canals. Theſe membranous tubes contain a fluid diſtinct from that contained in the common cavity of the veſtibule, nor have they any communication with the ſacculi, which contain the lapilli, although they are connected with them §. Theſe cartilaginous canals are of a cylindrical form, and, being as tranſparent as the fluid with which they are ſurrounded, are not readily diſtinguiſhed in diſſection. Each of the cartilaginous canals is dilated at one of its extremities into a little belly, which is called the ampulla.

The auditory nerve in cartilaginous fiſhes ‖ is firſt divided into two faſciculi, which are again ſubdivided into leſſer nerves. Theſe go to the three ſacculi lapillorum, and to the ampullulæ of the ſemicircular

* In many of the ſpinous or ſquamous fiſhes, there is only one. In cartilaginous fiſhes, theſe bodies are not like bone, but like ſoft chalk. In the ſpinous fiſhes, on the other hand, they are of the ſhape of the head of a ſpear, and hard like ſtone.

† The gelatinous matter is rather before the bones, and diſtending the little ſacculi.

‡ See plate 7. fig. 3 and fig. 4. D D D.

§ So Profeſſor Scarpa aſſerts, in contradiction to others.

‖ The fifth pair of nerves in fiſh anſwers to the ſeventh in man: has the ſame diviſion into the *portio mollis* and *dura*.

canals.

canals. Before the divifion of the nerve peculiar to the facculus pierces it, and is finally diftributed, it forms a fingular and intricate network of filaments. The branches to the ampullulæ are raifed on a partition which is oppofed to the mouth of the cylindrical part of the tube.

In the fpinous fifhes, the three femicircular canals unite in a common belly; but in cartilaginous fifhes, the pofterior femicircular canal is diftinct from the others.

In fifhes, all the parts of the ear are filled with a matter of a gelatinous confiftence, or vifcid fluidity; and the whole facculi and femicircular canals are furrounded with fluid. That jelly is the moft fufceptible of vibration, is evident when we fill a glafs, and allow a body to fall into it; for then the delicate vibration is communicated to the finger on the outfide of the glafs, or by ftriking the glafs, we may obferve the tremulous motion of the jelly. The femicircular canals, it is evident, are well adapted to receive the extenfive vibrations communicated through the bones of the head, and to convey them inward to the nerve expanded in the ampulla.

From the fimpler to the more perfect aquatic animals, we may trace feveral links of the chain by which nature advances towards the perfect ftructure of the ear. We return now to obferve, in the firft example of terreftrial animals, the moft fimple ftate of that part of the organ which receives the fenfation; but where the ftructure of the receiving organ is the moft fimple, the mechanifm for receiving the vibration and conveying it to the internal ear, is modified and adapted to the atmofphere.

OF THE EAR IN REPTILES AND AMPHIBIOUS ANIMALS.

In REPTILES, which form the intermediate clafs of animals betwixt fifhes and quadrupeds, the ear has alfo an intermediate ftructure; in fome individuals of this

clafs

clafs the ear refembles that of fifhes, fuch as we have defcribed, while, in others, it refembles more nearly the common ftructure of terreftrial animals.

In the falamandra aquatica, a variety of the lizard, there is a foramen ovale *, deep under the integuments. In this foramen there is a cartilage, in immediate contact with which, there is a common facculus lying in the cavity or veftibule; and in this little fac there is found a cretaceous matter: there are here, alfo, femicircular canals, with ampullulæ, and a common belly connecting them. In this animal, then, it is evident, the ear is fimilar in ftructure to that of the cartilaginous fifhes †.

In the FROG, the outward apparatus is different, but the internal ear is fimple ‡. Under the fkin of the fide of the head, a little behind the prominent eye, we find a large circular opening, which tends inward in a funnel-like form: and from the upper part of the circle of this meatus we find a fmall elaftic bone, or cartilage fufpended. This bone is in contact with the common integuments of the head, which are ftretched over the little cavity. This firft bone is placed at a right angle with a fecond bone, and both are lodged in a proper tympanum §. This fecond bone fwells out towards its inner extremity, and is accurately applied to the foramen ovale. The foramen ovale opens into a cavity which we muft call the veftibule, and which, in this creature, is peculiarly large in proportion to its fize. This veftibule contains a fac, upon which

* This is the appropriated appellation of the opening which leads from the outer cavity of the ear, or tympanum, into the feat of the proper organ where the nerve is expanded.

† It is faid by naturalifts, that the falamander never has been heard to utter a cry; and as dumbnefs is in general coupled with deafnefs, it is natural to fuppofe it has no ears. This is to confider the organ as fubfervient to converfation!

‡ See plate, fig. 5 and 6.

§ This Tympanum, being a cavity containing air, has communication with the mouth by a tube, which we fhall afterwards find called euftachian tube. Several have erroneoufly defcribed this animal as receiving founds through the mouth.

the nerve is expanded: it contains alſo a chalky ſoft concretion, which is of a beautiful whiteneſs, and of a regular figure when firſt ſeen, but has no ſolidity *. The veſtibule here, as in all other animals, being the immediate ſeat of the ſenſe, is filled with fluid.

In SERPENTS, the mechaniſm external to the ſeat of the organ is leſs complete than in the frog. From the ſcales behind the articulation of the bone which keeps the lower jaw extended, a little column † of bone ſtretches inward and forward. This bone has its inner extremity enlarged to an oval figure, and is inſerted into the foramen ovale. This creature has no membrana tympani, nor does it appear to have ſo good a ſubſtitute as the frog: the outer extremity of the bone ſeems rather attached to the lower jaw by a cartilaginous appendage and ſmall ligament ‡. Within the ſcull, ſerpents have the little ſac, with the cretaceous matter and ſemicircular canals, united by a common belly §.

In the TURTLE, we find a proper tympanum, and by lifting the ſcaly integuments from the ſide of the head a little above the articulation of the lower jaw, we open this cavity. Through this cavity there extends a very long and ſlender bone, which, upon the outer extremity, is attached by a little elaſtic bruſh of fibres to the cartilaginous plate under the integuments, while the inner extremity is enlarged, ſo as to apply accurately to the foramen, which opens into the veſtibule; and a paſſage alſo opens from the cavity of the tympanum into the fauces. In this animal, as in all which we have claſſed under the preſent diviſion, the internal ear conſiſts of a central cavity, or veſtibule, which contains a ſac with fluid, and cretaceous matter, and of three ſemicircular canals connected by a common belly. This common belly of the ſemicircular

* See fig. 6. D.

† Plate, fig. 7. B'.

‡ See Scarpa, tab. V. fig. IX.

§ Serpents are affected by muſic; and they will raiſe and twiſt themſelves with every variety of lively motion to the pipe and tabor.

canals

canals has no communication with the ſacculus veſtibuli which contains the cretaceous matter, further than as it lies in contact with it, and as they both lie ſurrounded by a fluid; they equally receive the impreſſion of the little bony column, the extremity of which vibrates in the foramen ovale.

There being enumerated forty or more varieties of the LACERTA OR LIZARD, many of theſe have very different habits. Some of them never paſs into the water, but inhabit dry and duſty places. The lacerta agilis or common green lizard, which is a native both of Europe and of India, is nimble, and baſks, during the hot weather, on the trunks of old trees and on dry banks; but on hearing a noiſe it retreats quickly to its hole. It has the ſkin over the tympanum extremely thin, and ſuch as to anſwer preciſely the office of the membrane of the tympanum. So all the varieties of reptiles which, in their habits and delicacy of hearing, reſemble terreſtrial animals, have either the membrane of the tympanum or a ſkin ſo delicate as to produce the ſame effect; while thoſe which inhabit the water, have a rough integument, or a hard ſcale, drawn over the tympanum. Beſides this, ſome have a ſmall muſcle attached to the bone, which runs acroſs the tympanum; it is like the tenſor tympani, and is another ſtep towards the proper ſtructure of the terreſtrial ear.

OF THE EAR IN BIRDS.

Comparing the internal ear of birds with that of thoſe animals which we have already deſcribed, we find a very important addition. We find here the internal ear (or labyrinth, as we may now call it,) conſiſting of three diviſions: the veſtibule, or middle cavity; the ſemicircular canals; and the cochlea; which laſt is an additional part, and one which we have not in the claſs of animals already deſcribed. Leading into theſe three cavities, there are two foramina;

mina: the FENESTRA ROTUNDA, and the FENESTRA OVALIS; and both theſe openings have a membrane ſtretched over them in the freſh ſtate of the parts. The firſt, the feneſtra ovalis, or foramen ovale, receives the oſſiculus auditus, which is in birds like that which we have already deſcribed in reptiles*. This oſſiculus connects the membrana tympani (which is here of a regular form) with the veſtibule, and conveys the vibration of the atmoſphere to it.

The ſemicircular canals are here alſo three in number, and are diſtinguiſhed by the terms minor, major, and maximus; but as the major and minor coaleſce at one of their extremities, and enter the veſtibule together, the ſemicircular canals open into the veſtibule by only five foramina in place of ſix. Each of the ſemicircular canals is dilated at one extremity into an elliptical form, while the other extremity is of the natural ſize of the diameter of the tube. Theſe canals are formed of the hard ſhell of bone, and are ſurrounded with bone, having wider and more open cancelli.

In the dry ſtate of the parts, we find a cord paſſing through the ſemicircular canals, which ſome have called the ZONULÆ NERVOSÆ. But theſe are the membranous canals, which are contained within the bony ones, dried and ſhrunk up. Within the bony cavities of the labyrinth, there is laid a pellucid membrane, which contains a fluid, has the nerves expanded upon it, and is the true veſtibule and ſemicircular canals;

* Mr. Home, in his lecture on the muſcularity of the membrana tympani, (vid. Phil. Tranſ. A. 1800), ſays, in birds this membrane has no tenſor muſcle to vary its adjuſtments, but is always kept tenſe by the preſſure of the end of the ſlender bone. This is a very imperfect account of the mechaniſm of the tympanum in birds. There are two bones, or one ſmall bone with a cartilage, which lies along the membrana tympani. This elaſtic cartilage has two little tendons attached to it. Even the ſlender bone which ſtretches from the cartilage to the foramen ovale, the inner extremity of which is enlarged to fill up that hole, ſeems to have a ſmall tendon inſerted into it; but whether this be a muſcular or ligamentous connection, I am unable at preſent to ſay.

while

while the bony caſe, which we have deſcribed, is merely the mould of theſe and the ſupport of their delicate texture *.

The COCHLEA, one of the three diviſions of the labyrinth, is but imperfect in birds, when compared with that part of the organ in quadrupeds and in man. The cochlea in birds conſiſts merely of two cylinders, formed of cartilage, which are united toward their further extremity. While the oppoſite extremities diverge, and while one of theſe cylinders opens into the veſtibule, the other opens outward into the cavity of the tympanum †.

That which more than any other circumſtance diſtinguiſhes the organ of birds from that of animals inhabiting the waters, is the want of the bone or ſtony concretion in the ſacculus veſtibuli.

CHAP. IV.

OF THE HUMAN EAR.

THE anatomy of the human ear will naturally be conſidered under three heads: the external ear: the tympanum; and the labyrinth. The OUTWARD EAR requires no definition. From the outward ear there is a carti-

* I lately, by accident, drew out the ſacculus veſtibuli and ſemicircular canals from the bony part of the ear of a bird, and I found the membranous ſemicircular canal to conſiſt apparently of the ſame pellucid elaſtic matter with thoſe of fiſhes.

† We find Mr. Home ſaying that the cochlea is neither abſolutely neceſſary to fit the organ to be impreſſed by ſounds communicated through the air, nor to render it what is termed a muſical ear; and that this is ſufficiently proved by that part being wanting in birds, whoſe organ is particularly adapted to inarticulate ſounds. That the cochlea is not neceſſary to the communication of ſound through the atmoſphere, we have ſeen from the examination of the ear of the reptiles. But ſince we ſee that it forms part of the labyrinth in birds, we may be led to doubt Mr. Home's concluſion.

a cartilaginous tube, which leads into the tympanum. The TYMPANUM is the cavity within which is placed that mechanifm of bones and mufcles which encreafes the ftrength of the vibration, and conveys it inwards to the labyrinth. The LABYRINTH is the general name of thofe intricate canals which contain the expanded nerve, and the immediate feat of the organ.

SECTION I.

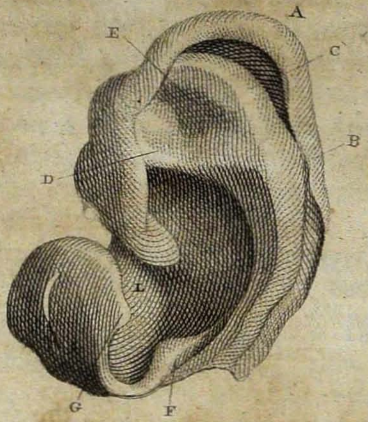
OF THE EXTERNAL EAR.

The EXTERNAL EAR is formed of an elaftic cartilage, covered with very thin integuments. The apparently irregular furfaces of the outer ear will be found, upon examination, to be fo formed that the finuofities lead gradually into each other, and finally terminate in the concha or immediate opening of the tube of the ear. By the conftant motion of the external ear of quadrupeds, we fee its importance to them both in collecting found, and in judging of its direction. In moft men, the motion of the ear is loft, but fome men ftill retain it; and this is very remarkable, that when the more internal mechanifm of the ear is injured, and ceafes to ftrengthen the found before it conveys it inwards to the labyrinth, the external ear refumes the office to which it was originally adapted, and by a degree of motion and erection, affifts the hearing. In Europeans, the outward ear is in a great degree flattened to the head by the drefs; but in Eaftern nations, and in ancient ftatues, we fee the ears ftand prominent, and bear a part in the fymmetry and expreffion of the whole head. The mufcles moving the cartilages, befides, being intended to give motion, appear to have a more effential ufe in giving a due tenfion to the outward ear. Thefe cartilages are furrounded with their peculiar pericondrium; but as to their veffels and nerves, it feems

ſeems very ſuperfluous to give a minute deſcription of them here.

When the cartilages are diſſected they appear thus:

Fig 18



A. The HELIX. It is the outer margin, the edge of which is turned over and forms the cavitas innominata.

B C D. The ANTHELIX. It is very prominent; of a triangular ſhape; and within the outer rim or margin.

E. The SCAPHA, which is a depreſſion or cavity on the anterior part of the anthelix.

F. The ANTITRAGUS.

G. The TRAGUS. Theſe are the two prominent points which approach each other, and form the margin of the great cavity of the ear.

L. The CONCHA, or great cavity of the ear, and which is the trumpet-like opening of the meatus auditorius externus. The few pale coloured fibres which are found on the cartilages, are ſcarcely to be recognized as muſcles *.

* See Falſalva & Santorini.

The

The LOBE of the ear, or that part which hangs down and is pierced for the ear-ring in women and ſavages, conſiſts of ſkin and cellular ſubſtance merely.

The MEATUS AUDITORIUS EXTERNUS, is the tube which leads into the tympanum This tube is partly bony and partly cartilaginous. The outer portion of the tube is cartilaginous, and about three quarters of an inch in length, and is divided by fiſſures. The internal part of the tube is formed in the bone, as we find upon turning to the deſcription of the temporal bone.

GLANDS OF THE PASSAGE. The cuticle, covering the inſide of the tube, is very fine, and there project from it many ſmall hairs which ſtand acroſs the paſſage. Under this ſkin there is a ſet of ſmall glands, which pour their ſecretion into the tube, and are called the GLANDULÆ CERUMENOSÆ *. Theſe glands, ſecreting the wax of the ear, have their little ducts opening betwixt the roots of the hairs; and this ſecretion, with the hairs which ſtand acroſs the paſſage, guards the internal parts of the ear from inſects. The whole paſſage, conſiſting of the canal of the temporal bone and the cartilaginous tube placed upon it, has an oblique direction. It firſt paſſes upward and forward, and then makes a ſlight curve to deſcend to the membrane of the tympanum.

This external tube of the ear, being of the nature of a ſecreting ſurface, and expoſed to the air, is liable to inflammation. There follows a dryneſs of the paſſages, and then a more fluid ſecretion. If the inflammation of the tube ſhould extend within the bones, then, like the affections of all parts ſurrounded with ſolid

* " Hæ figuram obtinent variam; major tamen harum pars vel " ad ovalem, vel ad ſphæricam accedit colore tinguntur flavo ab " humore in earum folliculis contento qui ob aſſiduam fibrarum car" nearum reticularium preſſionem, per cutis correſpondentia fora" mina in meatus auditorii cavitatem tranſmittitur." Valſalva de aure humana. p. 10.

ſolid bone, the pain is extreme and the danger conſiderable: there is not only ſuppuration in the tympanum and deſtruction of the membrana tympani, but the diſeaſe may be ſtill further communicated internally. Hildanus gives us an obſervation of the effects of a ball of glaſs dropt by accident into the ear, in which the inflammation was ſo extenſive, and the pain ſo excruciating, that the whole ſide of the head and even the arms and leg of that ſide were affected, in conſequence of the brain partaking of the inflammation. Such things as peas and cherry-ſtones and pins are very apt to be put into the ear by children; and awkward attempts to extract the foreign body, very often puſh it further in; and acrid fluids put into the ear to kill inſects, have forced them deeper, with ſuch an increaſe of pain as has thrown the patient into a condition little ſhort of delirium. A defective or too profuſe ſecretion from the glands of the tube, will cauſe a degree of deafneſs: and ſometimes the wax is ſo indurated as to cauſe a very obſtinate deafneſs *.

In the fœtus, the concha and meatus externus are narrow, and there is ſecreted a thick white ſtuff, which defends the membrane of the tympanum from the contact of the waters of the amnios. This, after birth, falls out in pieces along with the ſecretion of the wax; but, in ſome inſtances, it has remained and become very hard. The deafneſs from birth, cauſed

* See Valſalva, p. 10. "Talis ſunditalis a duodecim annis affligentis curatio." The older writers treat of the "Auditus læſio a ſordibus aurium lapideſcentibus." See *Bonetus*, & Jul. *Caſſertus Placantinus*, "*De auditus organo*," *lib.* 1. *cap.* 20. *p.* 90. There is alſo mention made of an adventitious membrane, cloſing up the paſſage and ſtretched above the membrana tympani. This is produced by a foul ſecretion, and reſembles that which ſtuffs up the paſſage in the fœtus. See FABRICIUS de Chirurg. operat. cap. de aur. Chirurg. VESLINGIUS Anat. cap. 16. See Experiments on the ſolvents of the Ear-wax, by Dr. Haygarth, Med. Obſ. and Inquiries, vol. iv. p. 198. He gives the preference to warm water over every other ſolvent.

by

by this accident, is often thought to depend upon an organic defect, and so is neglected.

SECTION II.

OF THE TYMPANUM OR MIDDLE CAVITY OF THE EAR, AND ITS DISEASES.

THE ANATOMY OF THE TYMPANUM.

In the fœtus, the cavity of the tympanum is superficial, compared with that of the adult; for what forms a tube in the latter, is in the former merely a ring, which is attached to the squamous portion of the temporal bone *: upon this circular bone the membrane of the tympanum is extended.

The cavity of the tympanum is very irregular; intermediate betwixt the membrane which is extended across the bottom of the external tube and the labyrinth or internal ear. It contains no fluid, as the labyrinth does; but is really a cavity, having a communication with the external air through a tube which leads into the fauces. The tympanum communicates also backwards with the cells of the mastoid process †. The inner extremity of the meatus externus forms a circle which is pretty regular, and upon which the membrane of the tympanum is extended. That part of the cavity of the tympanum which is opposite to the termination of the meatus externus, is very irregular. It has in it the foramen rotundum and the foramen

* See plate 8. fig. 3.

† When Valsalva, in a case of ulceration and caries on the mastoid process, threw in his injections, he found them flowing out by the mouth: viz. by the eustachean tube through the tympanum. See Val. de aure humana, p. 89.

 ovale;

ovale; and betwixt theſe, there is an irregular boney tuberoſity from which there ſtretch back ſome exceedingly ſmall ſpiculæ of bone, which connect themſelves with the margin of the irregular cavity of the maſtoid proceſs.

The FORAMEN OVALE* is in the bottom of a deep ſinus; it is not ſtrictly of an oval form, but has its lower ſide ſtraight, while the upper margin has the oval curve. This opening leads into the veſtibule or central cavity of the labyrinth.

The FORAMEN ROTUNDUM is more irregular than the oval hole. It does not look directly forward, like it, but enters on the ſide of an irregular projection: it does not lead into the veſtibule, but into one of the ſcalæ of the cochlea. In the recent ſtate of the parts, the perioſteum covering the ſurface of the cavity of the tympanum, takes away much of its irregularity. Where the tympanum leads backward into the CELLULÆ MASTOIDEA, this perioſteum is alſo continued.

The EUSTACHEAN TUBE† extends forward from the cavity of the tympanum, and opens behind the palate‡. In the dry bones, the euſtachean tube is more like an accidental fiſſure, than a regular paſſage, eſſential to the œconomy of the ear. It appears thus irregular in the bones from the tube being towards the back of the noſe, compoſed of a moveable cartilage covered with a ſoft membrane; as the tube approaches the opening behind the palate, it widens into a trumpet ſhape; and the extremity of the tube is governed by muſcular fibres.

There can be no doubt that the Euſtachean tube is deſigned for admitting the free acceſs of air into the cavity of the tympanum, that, by preſerving a due balance betwixt the atmoſphere and the air contained

* Feneſtra ovalis.

† Iter a palato ad aurem.

‡ By ſome older writers, the euſtachean tube is called aqueduct, becauſe they conceived that humors were evacuated from the tympanum by this paſſage.

within

within the ear, the motion of the membrane of the tympanum may be free. This, at leaſt, we know, that, when the extremity of the euſtachean tube is cloſed, we ſuffer a temporary deafneſs, which can be accounted for only by the confined air wanting a due degree of elaſticity to allow the vibration of the membrane of the tympanum. I conceive it to be neceſſary, that the air in the tympanum be changed occaſionally, which is, perhaps, accompliſhed by ſome actions of the throat and fauces forcing a new body of air into the euſtachean tube. The extremity of the euſtachean tube, next to the throat, may be temporarily obſtructed by the cynanche tonſillaris, which is frequently attended with pain, ſtretching from the throat to the ear; or it may be cloſed by inflammation and adheſion of its mouth, by adheſion of the ſoft palate to the back of the fauces, by polypus in the noſe, reaching down into the fauces and compreſſing it *.

OF THE MEMBRANA TYMPANI.

The membrane of the tympanum is extended over the circular opening of the bottom of the meatus externus. It has a little of an oval ſhape, and lies over ſomewhat obliquely, ſo that its lower margin is further inward than the upper. Its uſe is, to convey the vibrations or oſcillation of the atmoſphere, collected by the outer ear, inwards to the chain of bones in the tympanum. Although this membrane be tenſe, it is not ſtretched uniformly like the parchment of a drum, but is drawn into a funnel-like ſhape by the adheſion of the long proceſs of the malleus to its centre. It

* The following caſe is from Valſalva :—"Quidam plebeius "ulcus gerebat ſupra uvulam in ſiniſtra parte, quod quidem eam, "quam invaſerat, partem exeſerat atque abſtuleret ſic, ut ulceris "cavitas cum extremo ſiniſtræ tubæ orificio communicaret. Igitur "quoties homo mollem turundam remediis imbutam in ulceris "cavitatem intrudebat: toties illico ſiniſtra aure evadebat ſurdus, "taliſque permanebat toto ex tempore quo turunda in ulcere relin-"quebatur;" p. 90.

consists of two layers of membrane, and has, naturally, no perforation in it; and the experiments of air and the smoke of tobacco sent from the mouth through the ear, succeed only in those who have had the membrane of the tympanum partially ruptured or eroded by ulceration. This membrane is transparent; and when we look into the tube of the ear, and direct a strong light into it, we observe it to be of a shining tendinous appearance.

The inner lamina of the membrana tympani is very vascular. It has, indeed, been said, to resemble the iris, both in its profusion of vessels, and in the manner of their distribution *. This is carrying the conceit of their analogy too far. I have observed an artery of a very large size, (compared with the surface to be supplied), running by the side of the long process or handle of the malleus. In this course, it is giving out small branches; and when the trunk arrives at the extreme point of the long process of the malleus, it divides into two branches, the extreme subdivisions of which run towards the margin of the membrane. This artery is, nevertheless, too small to require us particularly to avoid it in the puncturing of the membrane for deafness, produced by obstruction of the eustachean tube.

The opinions regarding the muscularity of the membrane of the tympanum, shall be reserved until we have considered the whole mechanism of the parts in the tympanum.

OF THE CHAIN OF BONES IN THE TYMPANUM.

The vibrations of the membrane of the tympanum are transmitted to the foramen ovale by four moveable bones; the malleus, incus, os orbiculare, and stapes. These bones are named from their shape, and the

* See Mr. Home's lecture on the structure and use of the membrana tympani. Phil. Transact. Part I. 1800.

names

names aſſiſt in conveying an idea of their form. They are ſo united by articulation and ſmall ligaments, as to form an uninterrupted chain ; and, while they tranſmit the vibration, their mechaniſm is ſuch, that they ſtrengthen the impulſe. They have alſo ſmall muſcles attached to them, by which it is probable, the whole apparatus has a power of adapting the degree of tenſion to the force of the impulſe communicated to the membrane of the tympanum. I conceive that they encreaſe the power of the ear for receiving the weaker ſounds, and are, at the ſame time, a guard to the internal parts, from ſuch violent ſhocks as might injure the nerve.

How neceſſary it ſometimes is to damp and ſuffocate, in ſome degree, piercing ſounds, we muſt all be ſenſible: and in thoſe who are habitually expoſed to the ſudden eruption of ſound, the ſuſceptibility of the nerve is injured, and they become very deaf. We have, in a late publication, an example of this in blackſmiths, in whom, it is common to find a degree of deafneſs ; and we find old artillery-men quite deaf, from the long practice of their profeſſion.

The MALLEUS * receives its name from a reſemblance to a hammer or mallet: it is, in ſome degree, like a bludgeon ; the great head ſtands obliquely off from the body of the bone, (if ſuch it may be called), like the head of the thigh-bone. Anatomiſts can ſcarcely be blamed, if, in deſcribing the proceſſes of this bone, they forget the body. I ſhould conſider that part as the body of the bone which ſtretches down from the circular margin of the tympanum, and is attached to the membrane, or what we ſhould conſider as the handle of the mallet. This part of the bone ſtands at an angle with the head and neck ; tapers towards the extremity, and is a little curved down towards the membrane. From the larger end of the body of the bone there ſtands out an acute proceſs ; and from the neck attaching the bulbous head to the

* See plate 9. fig. 1. A.

body of the bone, there ſtands out a very ſlender proceſs, which is often broken off. The great head of the bone does not form a regular ball to be ſocketed in the body of the incus; there are irregularities in the contiguous ſurfaces of both the bones.

THE INCUS * is the ſecond bone of the chain; it receives its name from its reſemblance to the blackſmiths' anvil. It more reſembles a tooth with two roots. On the ſurface of the body, it has a depreſſion like the ſurface of the firſt molaris. Into this depreſſion of the incus the head of the malleus is received. The ſhorter of the two proceſſes, and the body of the bone lie on the margin of the circular opening of the tympanum; and the acute point of this proceſs is turned back into the opening of the maſtoid cells. The long leg or proceſs of the incus hangs down free into the tympanum †, and has attached to its point the os orbiculare.

The os ORBICULARE is like a grain of ſand, and is the ſmalleſt bone of the body: it is a medium of articulation betwixt the incus and ſtapes.

THE STAPES‡ or ſtirrup is well named, for it has a very cloſe reſemblance to a ſtirrup-iron; the little head is articulated with the os orbiculare: the arch of the bone is exactly like that of the ſtirrup-iron, but elegantly grooved within, ſo as to give lightneſs to the bone. The baſe anſwering to that part of the ſtirrup-iron upon which the foot reſts, is not perforated, nor is it of a regular form, but is flat on one ſide, correſponding with the foramen ovale. It is this baſe of the bone which is attached to the membrane ſtretched over the foramen ovale.

CONNECTION AND MOTION OF THESE BONES.

The malleus hanging on that part which we have called the neck of the bone, has the long handle or

* See plate 9. fig. 1. B.

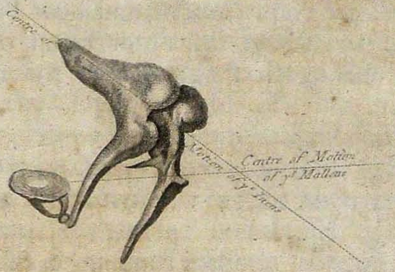
† See plate 4. fig. 1. D.

‡ See plate 9. fig. 1. C.

body

body of the bone ſtretched down upon the membrane of the tympanum. It is, conſequently, deſtined to receive the oſcillations of that membrane.

The head of the malleus is ſo articulated with the incus, that the degree of motion communicated to that bone is much encreaſed,



From this ſcheme, we ſee, that the head of the malleus is ſo articulated with the body of the incus, that the centre of motion of the incus is in a line drawn through the centre of its body, and, conſequently, that the extremity of the long proceſs, to which we ſee the os orbiculare and ſtapes attached, moves through a greater ſpace than that which receives the impulſe of the head of the malleus. Thus, a very ſmall degree of motion communicated by the head of the malleus to the body of the incus, muſt be greatly encreaſed in the extremity of the long proceſs of the incus, and, conſequently, this mechaniſm of the bones eſſentially aſſiſts in giving ſtrength to the vibration which is traſmitted inward to the ſeat of the nerve.

The os orbiculare ſtands ſimply as a link of communication betwixt the extremity of the incus and the upper part of the ſtapes, and its uſe is evidently to

 promote

promote the accurate and perpendicular motion of this long lever of the incus upon the head of the ſtapes: for, if this bone had not been ſo placed, the motion of the long lever of the incus muſt have given an obliquity to the impulſe upon the ſtapes. The baſe of the ſtapes almoſt completely fills up the foramen ovale. It is ſeated on a membrane which is ſtretched over the foramen *. The ſtapes, then, acts like a piſton on a membrane of much leſs circumference than that of the membrana tympani. From all which conſiderations, we may learn how much, and how ſtrongly, the agitation of the air in the outer canal of the ear is encreaſed, before it ſtrikes upon the fluids of the labyrinth.

OF THE MUSCLES WITHIN THE TYMPANUM †.

The laxator tympani runs in a fiſſure of the temporal bone on the outſide of the Euſtachean tube, and is inſerted into the long proceſs of the malleus. THE TENSOR TYMPANI ‡ runs alſo by the ſide of the euſtachean tube; it is inſerted into the body of the malleus; it is a long and ſlender muſcle. The external or ſuperior § muſcle of the malleus, which is denied by ſome anatomiſts to be of the nature of muſcle, comes down from the upper part of the tympanum, and is fixed by a ſmall tendon to the neck of the malleus.

THE STAPEDIUS || is the ſmalleſt muſcle, and is attached to the ſmalleſt bone. It has a ſmall round

* Valſalva has the following obſervation ſee page 24. "Olim "namque in cujuſdam ſurdi cadavere ſurditatis cauſam in eo ſitam "inveni nempe quod indicata membrana in ſubſtantiam oſſeam in"durata, unum continuatum os conſtituebat cum baſi ſtapedis et "margine feneſtræ ovalis."

† Muſculus proceſſus minimi mallei. Valſalva.

‡ Muſculus proceſſus majoris mallei.

§ Muſculus proceſſus minoris. Valſalva.

|| This muſcle is particularly ſtrong in the horſe, where it was firſt diſcoverd by Caſſerius.

fleſhy

flefhy belly, taking its origin from the rough fide of the tympanum, and is inferted by a fmall round tendon into the head of the ftapes.

As all thefe mufcles are inferted either into the malleus or ftapes, and not into the middle bone, it would appear that their operation is chiefly upon the membranes of the tympanum, and of the foramen ovale, through the medium of the bone immediately attached to them.

Mr. Home, in the Philofophical Tranfactions for 1800, afferts, that the membrana tympani is mufcular; that its fibres run from the circumference towards the centre; and that they are attached to the malleus.

But, what is the fuppofed ufe of this mufcular membrane? Mr. Home fays, it is principally by means of this mufcle that accurate perceptions of found are communicated to the internal organ; that it is by means of this mufcle that the membrana tympani is enabled to vary its degree of tenfion, fo as to receive the vibrations in the quick fucceffion in which they are conveyed to it. But we have feen, that the tenfion and relaxation of the membrana tympani is already fufficiently provided for; "the malleus has three "mufcles by which it is moved; one of them is called "the tenfor, from its pulling the malleus inward and "tightening the membrane of the tympanum; the "other two act in an oppofite direction, and relax the "membrane *." We fhould naturally fuppofe this to be fufficient; but, according to Mr. Home, thefe mufcles act only to bring the membrane into fuch a degree of tenfion, as to enable the minuter changes of the mufcular membrane to have their full effect; and that the play of thefe mufcles gives the perception of grave and acute tones.

But the more favourite idea of Mr. Home is, that, upon the accurate adjuftment of the membrana tympani, the difference between a mufical ear, and one which is too imperfect to diftinguifh the different

* Mr. Home's Lecture.

notes

notes in mufic, depends; that this judgment or tafte is owing to the greater or lefs degree of nicety with which the mufcles of the malleus render the mufcular membrane capable of being truly adjufted; if the tenfion be perfect, all the vibrations produced by the action of the radiated mufcle will be equally correct, and the ear truly mufical.

Mr. Home proceeds upon the idea, that the membrane of the tympanum is like a mufical inftrument, or, as he expreffes himfelf, like a monochord; but he is fundamentally wrong in fuppofing, that it requires a more delicate organ to be perceptible of mufical tones than of articulate founds or language.

In the firft place, we may require an explanation of the ufe of that mufcle which is inferted into the ftapes. This ftapedius mufcle would feem to have the fame ufe, and to affect that bone in the fame manner, in which the mufcles of the malleus affect it. Surely Mr. Home will not go fo far as to fay, that the membrana feneftræ ovalis is alfo mufcular. It may be further worthy of attention, in confidering this fubject, that whatever affects the membrane of the tympanum, affects, alfo, the membrane of the veftibule; that, if the one be relaxed, the other is rendered tenfe, from the clofe connection that exifts between them through the chain of bones.

In the paper already quoted, the following cafe is given, as illuftrating the manner in which the lofs of the natural action of the mufcles affects the ear, in regard to its capacity for mufic. A gentleman, thirty-three years of age, who poffeffed a very correct ear, fo as to be capable of finging in concert, though he had never learned mufic, was fuddenly feized with a giddinefs in the head, and a flight degree of numbnefs in the right fide and arm. Thefe feelings went off in a few hours, but on the third day returned; and for feveral weeks he had returns of the fame fenfations. It was foon difcovered that he had loft his mufical ear; he could neither fing a note in tune, nor in the fmalleft degree perceive harmony in the per-

formance

formance of others. For some time, he himself thought he had become a little deaf, but his medical attendant was not sensible of this in conversation. Upon going into the country, he derived great benefit from exercise and sea-bathing.

In this case, continues Mr. Home, there appeared to be some affection of the brain, which had diminished the action of the tensor muscles of the membrana tympani, through the medium of the nerve which regulates their actions; this gradually went off, and they recovered their action.

Another case is given of a young lady who was seized with a phrenzy which lasted several years, when, from being without a musical ear, she came to sing with tolerable correctness, to the astonishment of her friends.

Now, to me, the symptoms of both cases argue an affection of the brain, and of the nerves. It is more probable that the delicate auditory nerve should be affected in such a disease, than that the portio dura should alone be affected.

We now proceed to put the incorrectness of this reasoning concerning the muscular power of the membrane of the tympanum, in a more particular point of view, leaving to Mr. Home's paper only the merit of ingenuity. Mr. Cooper was led to pay particular attention to the action of the membrane of the tympanum, from being consulted in a case where the membrane was lost with little injury to the function of the organ*. He

* Case. This gentleman had been attacked, at the age of ten years, with an inflammation and suppuration in his left ear, which continued discharging matter for several weeks: in the space of about twelve months after the first attack, symptoms of a similar kind took place in the right ear, from which matter issued for a considerable time. The discharge, in each instance, was thin, and extremely offensive to the smell; and in the matter, bones, or pieces of bones, were observable. The immediate consequence of these attacks was a total deafness, which continued for three months; the hearing then began to return; and, in about ten months from the last attack, was restored to the state in which it at present remains. Having filled his mouth with air, he closed the nostrils, and contracted the cheeks; the air thus compressed, was heard to rush through

He found, that, inftead of the total annihilation of the powers of the organ, the gentleman was capable of hearing whatever was faid in company, although the membrane of both ears was deftroyed. He could even hear better in the ear in which no traces of the membrane remained. This gentleman was only in a fmall degree deaf from the lofs of the membrane; but his ear remained nicely fufceptible of mufical tones, "for he played well on the flute, and had frequently "borne a part in a concert; and he fung with much "tafte, and perfectly in tune." This cafe puts afide, at once, that theory which fuppofes the mufical ear to depend on the minute play of the mufcles of the tympanum.

It appears, then, that the membrane of the tympanum may be deftroyed, that the bones may be wafhed out by matter formed in the tympanum, and ftill the patient retain the ufe of the organ. But this is only while the ftapes retains its place; for, if this bone be alfo deftroyed, the membrane of the foramen ovale will be deftroyed, and the fluids of the labyrinth be allowed to flow out, or be otherwife loft. We fee, that, if the chain of bones, and only a part of the membrana tympani be left, ftill this fhred of membrane, if it be not detached from the handle of the malleus, will vibrate in the air, and communicate thofe

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through the meatus auditorious with a whiftling noife, and the hair hanging from the temples became agitated by the current of air which iffued from the ear. When a candle was applied, the flame was agitated in a fimilar manner.

Mr. Cooper then paffed a probe into each ear, and he thought the membrane on the left fide was entirely deftroyed, fince the probe ftruck againft the petrous portion of the temporal bone. The fpace ufually occupied by the membrana tympani, was found to be an aperture without one trace of membrane remaining. On the right fide, alfo, a probe could be paffed into the cavity of the tympanum; but here, by producting it along the fides of the meatus, fome remains of the circumference of the membrane could be difcovered, with a circular opening in the centre, about the fourth of an inch in diameter. See Tranf. Roy. Soc. for 1800. Part I. p. 151.

vibrations through the other bones to the veſtibule. We ſee, alſo, that though the bones only remain, and though they be detached from the membrane of the tympanum, the ſound will ſtill be communicated. We ſee, that a rupture of the membrane will not deſtroy the organization ſo far as to prevent the hearing, unleſs there follow clots of blood or inflammation, ſuppuration, or fungus. When Mr. Cooper found that the membrana tympani could be torn without injuring the organ, he did not ſtop ſhort in his inveſtigation: but as he found, by daily experience, that obſtruction of the euſtachean tube cauſed deafneſs, he thought of puncturing the membrana tympani, as a cure for that kind of deafneſs. He expected, by this operation, to give elaſticity to the confined air. Accordingly, by puncturing the membrane of the tympanum with a ſmall trocar, he found with much ſatisfaction, that the hearing was inſtantly reſtored *.

Valſalva made a good diſtinction, when he ſaid, that the membrane of the tympanum was not abſolutely neceſſary to hearing, but only, to perfect hearing. We have, in this fact, the explanation of the following circumſtance, amongſt many others: " In naturali " ſurditate a conformationis vitio inter tandum iſtud " experimentum, (viz. an oſſiculi et membrana tympani aliquis ſit uſus auditum), quod inopinato et " feliciter ſucceſſit cuidam, qui intruſo auri ſcalpio in " aurem profundiſſime diſrupit tympanum, fregitque " oſſicula et audivit †." Willis alſo knew, that the deſtruction of the membrana tympani did not deprive the perſon of hearing. *Vid. de Anima Brutorum.*

* I am only afraid that ſuch punctures will not continue open, as in Valſalva's experiments they healed up very ſoon. But, when there is no other ingreſs and eſcape to the air in the tympanum, but through the punctured hole, it may tend to keep it open. See much of this in Morgagni Epiſt. An. XII. The membrana tympani is very vaſcular, I have it red with injection. See Ruyſch. fig. 9. tab. 9. Epiſt. An. VIII.

† Biolanus Encherid. Anat. lib. 4. c. 4. See alſo Bonetus de Aurium Affect. Obſerv. IV.

§ 2. OF

§ 2. OF THE DISEASES OF THE TYMPANUM.

Valſalva denied the exiſtence of perioſteum to theſe bones of the tympanum, while he allowed that they had minute veſſels diſtributed on their ſurfaces: but theſe veſſels he ſuppoſed to creep along the naked bone independently of any membrane. This, however, is contrary to all analogy *. Theſe bones, as well as the cavity of the tympanum, are covered with a very fine membrane or perioſteum, which after a minute injection, is ſeen covered with many ſmall and diſtinct veſſels, as well as with intermediate extravaſcular effuſions of the injection, as happens in injecting in other membranes.

When the tympanum becomes diſeaſed, there is fetid matter collected, the membrane of the tympanum ſuffers, and the ſmall bones are ſometimes diſcharged. In ſuch a caſe, we have little farther to do than, by injections, to prevent the matter from accumulating. But, let us not confound this ſerious cauſe of deafneſs with the ſlighter ſuppurations in the outer paſſage of the tube: although ſuch ſuppurations in the tube of the ear are apt, when neglected, to deſtroy the membrane of the drum or tympanum, and to ſpread diſeaſe to theſe internal parts.

Authors make a diſplay of the diſeaſes of the membrane of the tympanum under the titles relaxatio, tenſio nimia, induratio, and diruptio tympani †. We have ſeen how little rupture of the membrane affects the hearing, and may thence conclude, that theſe fantaſtic imaginings about tenſion and relaxation of the membrane deſerve little notice. The idea of relaxation of the membrane of the tympanum, I have no doubt, has ariſen from the effect of cold and moiſt weather in injuring the hearing; but deafneſs from this cauſe is not produced by relaxation of the mem-

* See Ruyſch. Epiſt. Anat. VIII. tab. 9.

† See Du Verney de Organo Auditus, p. 41.

brane

brane of the tympanum, but by ſwelling of the mouth of the euſtachian tube *.

Induration of the membrane is leſs of an imaginary diſeaſe, ſince there are inſtances of the membrane becoming thickened by inflammation, or cartilaginous, or oſſeous. The membrana tympani has been found to adhere to the extremity of the incus †. Independently of the want of elaſticity, which ſuch an adheſion muſt produce, the mechanical effects, the vibration of the bones, is prevented, and a degree of deafneſs is inevitable.

Fungous or polypous excreſcences from the glands in the outer paſſage of the ear, preſs back and deſtroy the membrane of the tympanum. In the cure of theſe by the knife, cauſtic, or ligature, there is much danger of injuring the membrane. Fungous tumors project from the membrane itſelf. A ſtroke upon the head will cauſe bleeding from the ear. This is often a ſign of concuſſion of the brain; that is to ſay, a ſhock ſo ſevere as to rupture the membrane of the tympanum, will moſt probably injure the brain ‡. After bleeding from the ear, ſometimes ſuppuration follows § ; and blood flowing thus from the membrane of the tympanum, or other part of the ear, runs back into the cavity of the tympanum, and, filling it with coagulum, cauſes deafneſs, by obſtructing the free motion of the bones and membrane. Mr. Cooper, in

* "Relaxatio fit ab humore ſuperfluo qui membranam hanc "humectat et ſymptoma hoc communiter cum obſtructione mea-"tus ex tumore glandularunm conjunctnm eſt, de qua jam ſupra "dictum eſt: multum autem facit ad difficultatem audiendi in per-"ſonis quæ defluxionibus catarrhoſis obnoxiæ ſunt et per eandem "rationem auſtri nebulæ et aer pluvius auditum minuunt ut experiri "quotidie poſſumus." Du Verney loc. cit. p. 41.

† See the London Philoſophical Tranſactions for 1800, Part. I. p. 5.

‡ When Valſalva found the ventricles of the brain full of blood, and blood alſo in the tympanum, he ſuppoſed that the blood in the latter was derived from the brain through certain foramina which he diſcovered. See. p. 30.

§ See Valſalva, p. 16.

a caſe of this kind, punctured the membrane, and, after a diſcharge of blood which continued for ten days, the hearing was gradually reſtored. It is ſuppoſed by that gentleman, that the blood effuſed becomes, in ſome inſtances, organized, ſo as to obliterate the tympanum cauſing permanent deafneſs.

The danger in ſuppuration and caries of the tympanum is, that the diſeaſe may penetrate backward into the maſtoid cells and labyrinth, or into the brain itſelf; for inflammation and ſuppuration ſo confined amongſt the deep receſſes of the bone, muſt give great torture, and be apt to extend the miſchief to the brain, or throw out matter on the inſide of the cranium, the effect of which muſt be mortal. Such, I think, I have ſeen to be nearly the effect of ſuppuration deep in the ear. In a man who had been deaf for many years, and who was killed by a fracture of the ſkull, I found the cells of the temporal bones filled with matter, and a thin greeniſh fluid lay betwixt the temporal bone and dura mater. I have ſince found the caries of the petrous bone from this cauſe fatal.

Valſalva gives us a caſe of injury of the head, in which the patient was relieved while the diſcharge of pus by the ear was free; but he died when it was entirely ſuppreſſed *.

But, after ſuch ſuppuration as we ſhould naturally think muſt totally deſtroy ſo delicate an organization, we are ſometimes agreeably ſurpriſed with a gradual recovery of the function. This is owing to the nerve accommodating itſelf or becoming ſenſible to a leſs forcible impreſſion, and by the ear acquiring new properties. I already mentioned that the deſtruction of the mechaniſm of the tympanum aroſe ſometimes

* Valſalva, p. 83. See alſo a caſe in Bonetus de Aurium Affect. Obſerv. I., and Gul. Ballonius Epid. et Ephem. lib. 2. p. 270. When the matter was ſuppreſſed, there came pain of the head, and weight, which yielded to no remedy : on diſſection, there was found an abſceſs within the ſkull. In Bonetus loc. cit., a caſe is related, in which an ignorant ſurgeon compreſſed a fiſtulous ulcer in the ear, and ſo cauſed the death of the patient.

from ſuppurations beginning in the outward ear; and we may ſuppoſe that the apparatus within the tympanum, when partially hurt, is sometimes capable of being, in ſome degree, replaced by a natural proceſs; of which the following caſe from Valſalva is a remarkable proof.

"I lately examined the ears of a woman whoſe hearing had been much injured by an ulcer of the tympanum and caries of the ſmall bone. I found the ear in which ſhe was deaf without a membrana tympani, and the ſtapes only remaining of the bones, and a fibrous maſs, like an excreſcence, in the tympanum. But, in the tympanum of the oppoſite ear, I found the membrana tympani almoſt entirely eroded; ſo that the malleus and incus were uncovered, and diſtinctly ſeen. I could even obſerve, that the long proceſs of the incus, which ſhould be articulated with the head of the ſtapes, was ſeparated from it: but nature had curiouſly reſtored the eroded membrane. Thus, from the edge of the injured membrane, a new membrana tympani was obliquely ſtretched acroſs the cavity of the tympanum, ſo as to exclude the malleus and incus from that cavity, but including the head of the ſtapes, as if nature, finding the ſeparated bones no longer neceſſary, had attached the membrane to the head of the ſtapes *". We have already remarked, that, when the organ of one ſide is injured, we hear ſo much better with the other, that we attend only to the ſenſation conveyed by it, and neglect the duller ſenſation. The conſequence of this, is, that the bad ear becomes worſe. It is much like that effect which takes place in eyes by ſquinting.

* See Valſalva de Aure Humana Tract. p. 79. In thoſe deaf from birth, it has been twice found that the *incus* was wanting. *See Bonetus de Aur. Affect. Obſerv.* IV.

SECTION III.

OF THE LABYRINTH.

The labyrinth is the internal ear; the proper ſeat of the ſenſe of hearing. It conſiſts of the veſtibule or middle cavity; of the ſemicircular canals; and of the cochlea. It has its name from thoſe cavities and tubes leading into each other in ſo intricate a manner, as to be followed out with much difficulty.

We underſtand that the cavities hitherto deſcribed in the human ear contain air, and communicate with the atmoſphere: but, in the cavities we have now to deſcribe, the nerve is expanded, and there is, in contact with it, not air, but an aqueous fluid. In treating of this diviſion of our ſubject, we have, firſt, to attend to the forms of the cavities, as ſeen when ſections are made in the dry bones next to the ſoft parts contained in thoſe cavities; and, finally, to the diſtribution of the nerves. To give an idea of the exquiſitely delicate and complex ſtructure of the many canals, excavations, openings, ſulci and foveæ, of the bones; of the tubuli, ſacculi, and partitions of the membranes; and, laſtly, of the ſoft expanſions of the nerves, without the aſſiſtance of plates, would be impoſſible. Albinus, in his academical annotations, begins very formally a chapter on the ear; but, after a few words, diſmiſſes the ſubject, referring merely to his plates.

The vestibule, or central cavity of the labyrinth, is of an oval form, and about a line and a half in diameter *. It has two remarkable pits or hollows in it, and has numerous foramina opening from it into the neighbouring cavities, beſides leſſer foramina for tranſmitting that portion of the nerve which is diſtributed on the ſacs contained in it. One depreſſion or fovea is in the back and lower part of the veſtibule, an-

* Du Verney Œuvres Anatomiques.

other

other in the outer and ſuperior part of it: the one is circular, the other ſemi-oval. Morgagni, and other anatomiſts, examining the dry bones, ſpeculated on their uſe in reverberating the ſound in the cavity; but we muſt not regard them in this unnatural ſtate: on the contrary, they contain in the living ſubjects membranous ſacculi filled with fluid, in which membranes the nerve is finally diſtributed. That foramen over which the ſtapes is placed, and which is called the foramen ovale, tranſmits the vibration into the veſtibule. For the foramen ovale opens directly into the veſtibule, and through the veſtibule, only, does the vibration of the bones in the tympanum reach the other parts of the labyrinth.

Semicircular canals. When we have cut into the veſtibule, by taking away that portion of the os petroſum which is behind the meatus auditorius internus, we ſee five circular foramina: theſe are the openings of the ſemicircular canals. There are three ſemicircular canals; and they are diſtinguiſhed by the terms, the ſuperior or vertical, the poſterior or oblique, and the exterior or horizontal. The one which, in this view, is neareſt, is the opening common to the inner ends of the poſterior and ſuperior ſemicircular canals. When we paſs a briſtle into this common foramen, and direct it upward, it paſſes along the ſuperior ſemicircular canal, and will be ſeen to deſcend from the upper part or roof of the veſtibule, almoſt perpendicularly on the foramen ovale, which is open, and immediately oppoſite. If, again, we paſs a briſtle into the foramen which is near the bottom of the cavity, (and which will be juſt upon the edge of the fracture that has laid open the veſtibule, if not included in it), it will come out by the opening common to the ſuperior and poſterior ſemicircular canal. It has paſſed, then, along the poſterior canal. The two openings of the exterior or horizontal canal are upon the back part of the veſtibule; and the canal itſelf takes a circle which brings its convexity to the confines of the maſtoid cells. Theſe canals are formed of a very hard

 brittle

brittle bone, their calibre is ſo ſmall as not to admit the head of a common pin; they form ſomewhat more than a half circle; and of each of them, one of the extremities is enlarged like the ampulula of fiſhes. Valſalva imagined that the enlarged extremities of theſe tubes were trumpet-like, to concentrate and ſtrengthen weak ſounds. We ſhall find, on the contrary, that there is in the human ear, as in fiſhes, a particular expanſion of the nerve in theſe extremities of the tube, oppoſed to the circulatory vibration of the fluids in the canals.

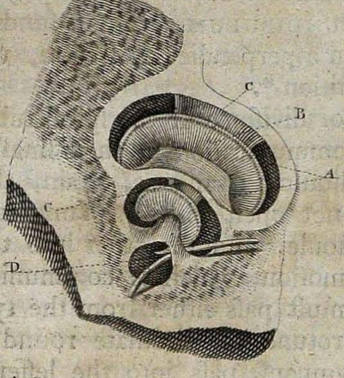
THE COCHLEA. The third diviſion of the labyrinth is the cochlea. It is ſo named from its reſemblance to the ſhell of a ſnail, or from the manner in which its ſpiral lamina turn round a centre like a hanging ſtair. It has been minutely, but not ſimply, deſcribed; and, indeed, there can be nothing more difficult, than to deſcribe it in words.

When the os petroſum is cut from around the cochlea, it is ſeen to be of a pyramidal ſhape, and to conſiſt of a ſcroll, making large circles at the baſe, and gradually leſſer ones towards the apex. It is formed in the moſt anterior part of the petrous bone, and has its apex turned a little downward and outward; and the baſe is oppoſed to the great cul de ſac of the internal meatus auditorius.

The ſpiral tube, of which the cochlea is compoſed, forms two turns and a half from the baſis to the point; and it conſiſts of the ſame hard and brittle matter with the ſemicircular canals. When the whole cochlea is cut perpendicularly in the dry ſtate of the bones, and when the membranes have ſhrunk away or ſpoiled, the ſides of the ſpiral canal appear like partitions, and are, indeed, generally deſcribed as ſuch. In conſequence of the ſpiral tube of the cochlea having its ſides cut perpendicularly, the cochlea appears as if divided into three circular compartments or ſucceſſive ſtages; but there is really no ſuch diviſion; becauſe the ſpiral turnings of the tube lead from the one into the other.

What

Fig. 19.
Cochlea



A. Scala. B. Lamina Spiralis
C.C. Modiolus. D. Infundibulum.

What gives particular intricacy to the ſtructure of this part of the labyrinth, is the LAMINA SPIRALIS. This ſpiral partition runs in the ſpiral tube of the cochlea, ſo as to divide it in its whole length; and, in the freſh ſtate of the parts, this lamina of bone is eked out by membrane, ſo as to form two perfectly diſtinct tubes. Theſe tubes are the SCALÆ COCHLÆÆ; they run into each other at the apex of the cochlea; but at the baſe, the one turns into the veſtibule, and the other opens into the tympanum by the FORAMEN ROTUNDUM.

In the middle of the cochlea there runs down a pillar, which is the centre of the circumvolutions of the ſcalæ. It is called the MODIOLUS. This pillar is of a ſpongy ſtructure; and through it the nerves are tranſmitted to the lamina ſpiralis, and ſides of the cochlea.

 The

The modiolus opens towards the apex of the cochlea like a funnel; and when we take away the outward ſhell of the apex of the cochlea, which is called the CUPOLA, we look into this expanſion of the upper part of the modiolus as into a funnel; it is therefore called the INFUNDIBULUM. The infundibulum is that part which, in a perpendicular ſection, we ſhould call the upper partition *.

The ſcalæ or diviſions of the ſpiral tube of the cochlea, have a communication at their ſmaller extremities in the infundibulum; and as, again, their larger extremities do not open into the ſame cavity, but one into the veſtibule, and the other into the tympanum, the vibrating motion, which is communicated through the cochlea, muſt paſs either from the tympanum into the foramen rotundum, circulate round the modiolus by the ſcala tympani, paſs into the leſſer extremity of the ſcala veſtibuli in the infundibulum, and circulate through it towards the baſe of the cochlea, until it paſs into the veſtibule; or it muſt paſs from the ſcala veſtibuli into the ſcala tympani. The firſt is the opinion of Scarpa and others. But I truſt it will afterwards appear, that the oſcillations of ſound are in the firſt place conveyed into the veſtibule, and thence circulate round both the ſemicircular canals and cochlea.

In the dry bones, when we cut into the cochlea, there appears a ſpiral tube, as I have deſcribed; with a partition running along it, and, of courſe, taking the ſame ſpiral turns with it towards the apex. This is the bony part of the lamina ſpiralis; but, as the membrane which extends from its circular edge quite acroſs the ſpiral tube of the cochlea, has ſhrunk and fallen away in the dry ſtate of the parts, the lamina ſpiralis is like a hanging ſtair, and the ſcalæ are not divided into diſtinct paſſages. In this bare ſtate of the ſhell of the cochlea, when we cut away the cupola or apex of the cochlea, and look down upon the infundibulum, we ſee the extreme point of the lamina ſpiralis riſing in an acute hook-like point.

* That is ſuppoſing the cochlea to reſt on its baſe.

The

The modiolus or central pillar, and the lamina ſpiralis which encircles it, are of the moſt exquisite and delicate ſtructure; for, through them the portion of the ſeventh nerve deſtined to the cochlea is conveyed. To ſay that the modiolus is formed of two central bones, is ſaying that there is no central column at all; or, that the modiolus is the cavity ſeen in the bottom of the meatus auditorius: and to affirm, at the ſame time, that the modiolus is a nucleus, axis, or central pillar, is a contradiction in terms.

When we break away the ſhell of the cochlea, and break off, alſo, the ſpiral lamina, we find the little funnel-like depreſſion in the bottom of the meatus internus reaching but a little way up into the centre of the cochlea.—We find this depreſſion of the meatus auditorius internus perforated with innumerable ſmall holes; and theſe foramina are ſo placed as to trace a ſpiral line, becauſe they give paſſage to the nerves going to the ſpiral lamina, and muſt take the form of the diminiſhing gyrations of the lamina ſpiralis. In the centre of theſe leſſer foramina, which are ſeen in the bottom of the great foramen auditorium internum, there is a hole of comparatively a large ſize, which paſſes up through the middle of the pillar. The modiolus is formed of a looſe, ſpongy texture, and reſembles the turns of a cork-ſcrew; and this ſpiral direction is a neceſſary conſequence of the lamina ſpiralis, being a continuation of the ſpongy or cribriform texture of the modiolus.

INTERNAL PERIOSTEUM OF THE LABYRINTH. We find that the veſtibule, the ſemicircular canals, and cochlea, beſides their ſoft contents, which we have yet to deſcribe, have their proper perioſteum, which, after a minute injection, appears vaſcular; and this, as it has appeared to me, is particularly the caſe with the laſt mentioned diviſion of the labyrinth. I ſee very conſiderable veſſels diſtributed on the veſtibule; particularly, I ſee their minute ramifications on the circular fovea, while very conſiderable branches are ſeen to courſe along the ſemicircular canals. In the cochlea, I ſee

I see diſtinct branches of veſſels riſing from the root of the lamina ſpiralis, and arching on the ſcalæ, to the number of ten in the circle; and, after a more minute injection, I have found the oſſeous part of the lamina ſpiralis tinged red; and the membranous part of a deep ſcarlet *.

We have obſerved the MEATUS AUDITORIUS INTERNUS to be a large oval foramen in the poſterior ſurface of the pars petroſa of the temporal bone. This tube tranſmits the ſeventh or auditory nerve. It is about five lines in diameter, but encreaſes as it paſſes inward; and appears to terminate in two deep fovea, which are divided by an acute ſpine. But the auditory foramen only appears to terminate in theſe fovea, for they are each perforated by leſſer holes, which lead into the three diviſions of the labyrinth, whilſt a larger one conveys a portion of the nerve through the cavities of the temporal bone altogether, and out upon the ſide of the face. This larger foramen is in the upper part of the ſuperior and leſſer fovea. It firſt aſcends to near the ſurface of the petrous part of the temporal bone †, and then deſcends and turns backward and takes a courſe round the tympanum above the foramen ovale; and cloſe by the poſterior ſemicircular canal. Its termination is the foramen ſtylo maſtoideum ‡. Where this canal of the portio dura advances towards the ſurface of the pars petroſa, it is joined by a very ſmall canal which extends from the videan hole on the fore part of the inclining face of the bone: again, after it has paſſed the tympanum, it is joined by a ſhort canal which receives the corda tympani, after it has paſſed the tympanum.

The other foramen which is in the upper and leſſer fovea of the meatus internus, is rather a cribriform

* In a preparation before me, I ſee a conſiderable artery derived from the baſilar artery, entering the meatus auditorius internus. From this trunk, I conceive that moſt of theſe arteries which I have deſcribed, are derived.

† In the fœtus, it becomes here ſuperficial.

‡ This is the aqueduct of Fallopius.

plate,

plate, as it is a deep pit with many foramina in it. Theſe lead into the veſtibule, and form the MACULA CRIBROSA VESTIBULI *. In the inferior and larger fovea, we obſerve ſeveral dark ſpots, which, when more narrowly examined, are alſo diſtinguiſhed to be cribriform plates, or collections of leſſer foramina. We particularly obſerve that conical cavity which is perforated with many little pores for tranſmitting the nerve into the cochlea, and which we have already mentioned. From the form which theſe foramina take this is named the TRACTUS SPIRALIS FORAMINOLOSUS. Theſe foramina, after paſſing along the modiolus cochleæ, turn at right angles, and paſs betwixt the plates of the lamina ſpiralis.

Beſides the tractus ſpiralis foraminoloſus, the bottom of the larger fovea has many irregular foramina, which are like cancelli: for very delicate ſpiculæ of bone ſtand acroſs ſome of them. There is a range of theſe foramina which ſtretches from the tractus ſpiralis. This may properly be called the TRACTUS CALTHRATUS RECTUS †; they do not lead into the veſtibule, but into the beginning of the lamina ſpiralis, where it divides the two ſcalæ cochleæ, and turns the orifice of one of them, (by a beautiful curve), out into the tympanum.

Nearer to the ridge which divides the two foveæ of the meatus internus, there is a little pit which has alſo a cribriform plate (like that which is in the upper fovea, and is called macula cribroſa); oppoſite to this point the inſide of the veſtibule is rough and ſpongy: it tranſmits a portion of the nerve to the ſacculus in the hemiſpherical ſinus of the veſtibule ‡.

* See Scarpa, Plate VII., fig. i. m.
† Tractus ſpiralis foraminuloſi initium. Scarpa.
‡ Scarpa.

OF

OF THE SOFT PARTS CONTAINED IN THE LABYRINTH.

Within the veſtibule, ſemicircular canals and cochlea, there are ſoft membranes independent of the perioſteum. Theſe form ſacculi and tubes which contain a fluid, and have the extreme branches of the portio mollis diſtributed among them. Betwixt the ſoft and organized ſacculi and tubes, and the perioſteum of the oſſeus labyrinth, a watery fluid is exuded.

SACCULUS VESTIBULI. The hemiſpherical and ſemi-eliptical foveæ which we have deſcribed in the veſtibule, contain, or at leaſt receive partially, two ſacculi. The ſacculus which is in the hemiſpherical cavity, receives the moſt convex part of the ſacculus veſtibuli. This ſac is diſtended with a fluid, and is pellucid, and fills the greater part of the veſtibule; for only a part of it is received into the fovea. It forms a complete ſac, and has no communication with the other ſoft parts of the labyrinth, though lying in contact with the alveus communis, preſently to be mentioned; and being ſurrounded with an aqueous fluid, it muſt receive the impreſſions of ſound in common with them.

ALVEUS COMMUNIS DUCTUUM SEMICIRCULARUM. This ſacculus lies in the ſemi-eliptical fovea of the veſtibule, or like the other ſacculus, is in part received into it. This ſacculus receives the extremities of the tubuli membranacei which lie in the ſemicircular canals; it is a little bag common to them, and connecting them altogether, as in fiſhes: it is filled with fluid, and is ſo pellucid, as to be diſtinguiſhed with much difficulty *. Upon preſſing the common ſac, or the ampullulæ of the ſemicircular canals, the fluids are ſeen to circulate along the membranous tubes of the canals. Theſe two ſacculi in the veſtibule lie together, and

* Proprio humore turgidus adeo tranſlucet ut ablongum bullulam aëream mentiatur. Scarpa, p. 47,

firmly

firmly adhere, but do not communicate; yet, (as may be eaſily imagined), they cannot be ſeparated without tearing the partition.

Tubuli membranacii. The tubuli membranacii are the ſemicircular tubes which paſs along the oſſeous ſemicircular canals, and to which the latter are ſubſervient, merely as ſupporting them. They are connected by means of the common alveus in the veſtibule, and form a diſtinct diviſion of the organ.

It was believed by anatomiſts formerly, that the oſſeous canals had the pulp of the nerve expanded on their perioſteum. But we find, on the contrary, that the membranous tubuli do not touch the bones, but are connected with them by tranſparent cellular membrane-like mucus. Each of the ſemicircular membranous tubes has one extremity ſwelled out into an ampulla of an oval form, anſwering to the dilated extremity of thoſe oſſeous tubes which we have already deſcribed. Theſe ampullæ have the ſame ſtructure and uſe with thoſe formerly mentioned in deſcribing the ear in fiſhes. When the central belly of theſe tubes is punctured, both the ampullæ and the membranous canals fall flaccid.

Beſides thoſe veſſels which we have deſcribed running along the perioſteum of the cavities of the labyrinth, veſſels alſo play upon the ſacculi and membranous tubes. The ampullæ of the tubes are, in a particular manner, ſupplied with blood-veſſels *.

In the cochlea there is alſo a pulpy membrane, independent of the perioſteum; but of this I can ſay nothing from my own diſſection.

* "Caeterum univerſum hoc canaliculorum membraneorum "alveique communis machinamentum, ſanguiferis vaſis inſtruitur, "quorum craſſiora, circum alveum communem, ſerpentino inceſſu "ludunt; crebra et conferta alia *ampullæ* imprimis recipiunt ob "quam cauſam rubellæ plerumque ſunt et cruore veluti ſuffuſæ." Scarpa, p. 47.

SEC-

SECTION IV.

OF THE NERVE.

As the ſeventh pair of nerves ariſes in ſeveral faſciculi, they form what would be a flat nerve, were it not twiſted into a cylindrical form, adapted to the foramen auditorium internum. While theſe faſciculi are wrapped in one common coat, they are matted together. In the canal, the nerve is divided nearly into two equal parts *; to the cochlea and to the veſtibulum and ſemicircular canals. Thoſe faſciculi, which are deſtined for the veſtibule, are the moſt conſpicuous; and on the portion deſtined for the ampullæ of the ſuperior and external canal, there is formed a kind of knot or ganglion.

Before the auditory nerves paſs through the minute foramina in the bottom of the meatus auditorius, they lay aſide their coats and become more tender and of a purer white colour; and, by being ſtill further ſubdivided by the minute branching and diviſions of the foramina, they cannot be followed, but finally expand in a white pulpy-like ſubſtance on the facs and ampullæ. We muſt, however, recollect that there was a difference to be obſerved in the apparent texture of theſe expanded nerves in the lower animals: we may obſerve here, alſo, that part of the nerve which is expanded on the common belly or ſacculus tubulorum, is ſpread like a fan upon the outer ſurface of the ſac, and has a beautiful fibrous texture; but upon the inſide of the ſac, upon which it is finally diſtributed it loſes the fibrous appearance. We muſt ſuppoſe its final diſtribution to be in filaments ſo extremely minute that we may call it a pulp; though by the term it muſt not be underſtood that an unorganized matter is meant.

* Of the portio dura we have already ſpoken:

That

That part of the nerve which ſtretches to the ampullæ, immediately divides into an opaque white mucous-like expanſion. Beyond theſe ampullæ, there has been no expanſion of the nerve diſcovered in the membranous tubes.

The ſacculus veſtibuli * is ſupplied by a portion of the nerve which perforates the macula foraminuloſa in the centre of the oſſeous excavation or that which receives into it part of the ſac. This part of the nerve is expanded in a ſoft mucous-like white matter in the bottom and ſides of the ſac.

A diviſion of the nerve, as we have already explained, paſſes from the meatus auditorius internus through the cribriform baſe of the modiolus into the cochlea. Owing to the circular or ſpiral form of the foramina when the nerve is drawn out from the meatus, its extremity appears as if it had taken the impreſſion of theſe foramina from the extremities of the torn nerves preſerving the ſame circular form. Theſe nerves, paſſing along the modiolus and ſcalæ cochleæ, are in their courſe ſubdivided to great minuteneſs. Part of them perforate the ſides of the modiolus, whilſt others paſs along betwixt the two plates of the lamina ſpiralis, and out by the minute holes in the plates and from betwixt their edges. Laſtly a central filament paſſes up through the centre of the modiolus, and riſes through a cribriform part into the infundibulum to ſupply the infundibulum and cupola.

Where the nerves paſs along the lamina ſpiralis, their delicate fibres are matted together into a network. According to the obſervations of Dr. Monro they are quite tranſparent on their extremities.

* i. e. In oppoſition to the ſacculus tubulorum.

CHAP.

CHAP. V.

OF HEARING IN GENERAL.

WHEN aerial undulations were, by the experiments on the air pump, firſt proved to be the cauſe of ſounds, philoſophers looked no further to the ſtructure of the ear than to diſcover an apparatus adapted to the reception of ſuch vibrations. When they obſerved the ſtructure of the membrane of the tympanum, and its admirable capacity for receiving theſe motions of the atmoſphere, they were ſatisfied, without conſidering the immediate objects of ſenſation. In the ſame way, an ignorant perſon, at this day would reſt ſatisfied with the fact that ſound was received upon the drum of the ear... But after ſo minutely explaining the anatomy of the ear, it becomes us to take a general ſurvey of a ſtructure the moſt beautiful which the mind can contemplate. We cannot ſay that it ſurpaſſes in beauty the ſtructure of other parts of the body: but the parts are adapted to each other, in a manner ſo ſimple, efficient, and perfect, that we can better underſtand and appreciate the harmony of their ſtructure than that of organs, which perform their functions by qualities and actions almoſt entirely unintelligible to us.

We ſee that the external ear collects the vibrations of ſound as it moves in the atmoſphere with circular undulation from the ſonorous body: here we may obſerve, that where the neceſſities of animals require them to be better provided with this external part of the organ than man, the ſuperiority is only in the ſimple perception of ſound; while man from the perfection of the internal organ, excels all animals in the capacity of the ear for articulate and muſical ſounds.

From the external ear we obſerve, that the trumpet-like tube conveys the ſound inward to the membrane of

of the tympanum. Behind the membrane of the tympanum, there is a cavity which in order to allow of the free vibration of the membrane, contains air.— When this air is pent up, by the ſwelling or adheſion of the Euſtachian tube, the elaſticity of the air is diminiſhed, and the membrane prevented from vibrating *.

In the tympanum, we have ſeen that the operation of the chain of bones is to encreaſe the vibration received upon the membrane of the tympanum, and to tranſmit it to the membrane of the foramen ovale. In the cavity of the tympanum we obſerved two foramina, the foramen ovale and the foramen rotundum, both of which lead into the labyrinth; but one of them (the foramen ovale) into the veſtibule, the other (the foramen rotundum) into the ſcala of the cochlea: now it becomes a queſtion, whether the oſcillations of ſound paſs by one or by both of theſe foramina?

It is the opinion of many, that while the chain of bones receives the motion of the membrane of the tympanum, the motion of this membrane at the ſame time cauſes a vibration of the air in the tympanum which reaches the foramen rotundum, and thus conveys a double motion through the cochlea.

In the labyrinth there is no air, but only an aqueous fluid: now this, we have ſeen, conveys a ſtronger impulſe than the atmoſphere; ſtronger in proportion to its greater ſpecific gravity and want of elaſticity; for an elaſtic fluid like air may be compreſſed by concuſſion, but an inelaſtic fluid muſt tranſmit fairly every degree of motion it receives. But if the fluid of the labyrinth be ſurrounded on all ſides; if, as is really the caſe, there can be no free ſpace in the labyrinth, it can partake of no motion, and is ill ſuited to receive the oſcillations of ſound. Againſt this perfect inertia of the fluids of the labyrinth I conceive the FORAMEN ROTUNDUM to be a proviſion. It has a membrane ſpread over it, ſimilar to that which

* See *Recherches*, &c. *relatives a l'organe de l'ouie et a la propagation des ſous*, par M. Perolle, Sociét. R. de Medecine, tom. iii.

 cloſes

closes the foramen ovale. As the foramen ovale receives the vibrations from the bones of the tympanum, they circulate through the intricate windings of the labyrinth, and are again transmitted to the air in the tympanum by the foramen rotundum. Without such an opening there could be no circulation of the vibration in the labyrinth; no motion of the fluids communicated through the contiguous sacculi, nor through the scalæ of the cochlea; because there would be an absolute and uniform resistance to the motion of the fluids.—But, as it is, the provision is beautiful. The membrane of the foramen rotundum alone gives way of all the surfaces within the labyrinth, and this leads the course of the undulations of the fluid in the labyrinth in a certain unchangeable direction.

To me it appears, that to give a double direction to the motion of the fluids, or to the vibration in the labyrinth, far from encreasing the effect, would tend to annihilate the vibrations of both foramina by antagonizing them. The common idea is, that there is a motion communicated through the membrane of the foramen rotundum along the scala tympani, and another through the foramen ovale into the vestibule, and through the vestibule into the scala vestibuli; and that the concussion of these meet in the infundibulum of the cochlea. But as there is no space for motion in the fluids, in either the one or other of these tracts, the vibration must have been received in the infundibulum at the same time that the motion was communicated to the membrane of the foramen ovale and rotundum; for if a tube full of water, a mile in length, loses one drop from the extremity, there must be an instantaneous motion through the whole to supply its place. The evident consequence of this double motion would be, (if they were of the same strength) to suppress all motion or vibration in the fluids of the labyrinth.

But we have shown that the strength of vibration communicated to the foramen ovale and foramen rotundum are not the same: for the mechanism of the bones

bones in the tympanum is ſuch as to accumulate a greater force or extent of motion on the membrana ovalis than is received upon the membrana tympani; therefore the leſſer vibration which is communicated through the medium of the air in the tympanum, cannot be ſuppoſed capable of opoſing the ſtronger vibration which circulates from the foramen ovale through the labyrinth, and returns by the foramen rotundum. Beſides, the air in the tympanum has a free egreſs, and cannot therefore ſtrike the membrane on the foramen rotundum forcibly.

For theſe ſeveral reaſons, I conceive that the following account of the manner in which the ſound is conveyed is erroneous:—" Et quo ad zonam cochleæ " ſpiralem quoniam altera cochleæ ſcala in veſtibulo " patet, altera a FENESTRA ROTUNDA initium ſumit, " atque earum utraque aqua labyrinthi repleta eſt, et " ſcalæ in apice cochleæ ſimul communicant, zona " ſpiralis inter duas veluti undas ſonoras media, a " tremoribus per vaſim ſtapedis, ſimulque ab iis per " membranam *feneſtræ rotundæ* advectis utraque in " facie percellitur et una cum percillis acauſtici nervi " per eam diſtributis contremiſcit: quibus porro om- " nibus, in ampullis videlicet canaliculorum ſemicir- " cularium, alveo eorum communi, ſacculo veſtibuli " ſpherico et lamina cochleæ ſpirali acauſtici nervi " affectionibus auditum contineri nemo non in- " telligit *."

As to the immediate ſeat of the ſenſe of hearing, there cannot, after what has been explained regarding the diſtribution of the nerves, remain any controverſy; though before the ſtructure of the ear was ſo well underſtood, ſome imagined that the veſtibule, others that the middle part of the ſemicircular canals, was the ſeat of hearing; others, again, that the lamina ſpiralis was better adapted for receiving the vibrations of ſound. It is evident that the ſoft expanſion of the nerve, in all the three diviſions of the labyrinth, is deſtined to receive the un-

* Scarpa, p. 61.

dulation

dulation of the contained fluids, and that this motion of the fluids gives to the nerve, or to the nerve and brain conjointly, the ſenſation of hearing.

Since we have, in ſome meaſure, traced the ſtructure of the ear from the animals of a ſimple ſtructure to thoſe of a more complicated organization, and have obſerved ſome parts of the ear common to all animals, ſome peculiar to certain orders; and ſince all have the ſenſe of hearing, more or leſs acute, it becomes natural to enquire what are the parts of the organ the moſt eſſential to the mere perception of ſound, and what parts conduce to a more perfect ſtate of the ſenſe.

All the external apparatus of the ear is not neceſſary to give the animal the ſimple perception of ſound.—There are many claſſes of animals altogether without them, and even in man we ſee that they are not abſolutely neceſſary; ſince when deprived of them by diſeaſe, man ſtill enjoys the ſenſe. He is deprived of no eſſential variety of the ſenſation; he is capable of perceiving the diſtinctions of articulate ſound; and ſtill poſſeſſes his muſical ear. The external apparatus of the ear, the membrane of the tympanum, the little bones, and even the external ear, only receive, concentrate, and encreaſe the tremors of the external air, and render the ſlighter impreſſions audible.

It would appear, that the ſimple ſac of the veſtibule is ſufficient to receive the impreſſion in ſome animals, and that in many the veſtibule and ſemicircular canals form ſolely the organ of hearing. It is evident, therefore, that theſe are the moſt eſſential parts. We ſee alſo an intention in the ſtrict ſimilarity of figure and place in theſe canals through all the varieties of animals, from fiſhes to man. It would ſeem to indicate, that there is in their form and poſition a peculiar proviſion for the oſcillation of ſound producing the full effect.

We find, however, that the cochlea is imperfect in birds; and that it is fully formed only in man, and in quadrupeds: we muſt, therefore, conclude, that it is ſubſervient to the more exquiſite ſenſations. I do not conceive

conceive that the cochlea or any part of the organ particularly conduces to the beſtowing of a muſical ear, although it is by hearing that we are capable of the perceptions of melody and harmony, and of all the charms of muſic; yet it would ſeem, that this depends upon the mind, and is not an operation confined to the organ. It is enjoyed in a very different degree by thoſe whoſe ſimple faculty of hearing is equally perfect *.

Even after ſtudying, with all diligence, the anatomical ſtructure of the ear, we cannot but be aſtoniſhed with the varieties to be found in the ſenſation; for example:—" The ear is capable of perceiving four or " five hundred variations of tone in ſound, and pro- " bably as many different degrees of ſtrength; by com- " bining theſe, we have above twenty thouſand ſimple " ſounds that differ either in tone or ſtrength, ſup- " poſing every tone to be perfect. But it is to be ob- " ſerved, that to make a perfect tone, a great many " undulations of elaſtic air are required, which muſt " all be of equal duration and extent, and follow one " another with perfect regularity; and each undula- " tion muſt be made up of the advance and recoil of " innumerable particles of elaſtic air, whoſe motions " are all uniform in direction, force, and time. Hence " we may eaſily conceive a prodigious variety in the " ſame tone, ariſing from irregularities of it occaſioned " by conſtitution, figure, ſituation, or manner of ſtrik- " ing the ſonorous body; from the conſtitution of the " elaſtic medium, or its being diſturbed by other " motions; and from the conſtitution of the ear itſelf " upon which the impreſſion is made. A flute, a " violin, a hautboy, a French horn, may all ſound the " ſame tone, and be eaſily diſtinguiſhable. Nay, if " twenty human voices ſound the ſame note, and with " equal ſtrength, there will ſtill be ſome difference. " The ſame voice, while it retains its proper diſtinc- " tions, may yet be varied many ways: by ſickneſs

* See Reid's Enquiry.

" or health, youth or age, leannefs or fatnefs, good or " bad humor. The fame words, fpoken by foreigners " and natives, nay by different provinces of the fame " nation, may be diftinguifhed *."

That this variety of fenfation does not entirely depend upon the ftructure, but is the operation of the fenfe and intellect conjointly, appears from the long experience which is requifite to give this perfection. Nature is bountiful in providing the means of fimple and acquired perception, but the latter is the refult of long experience and continued effort, though we have loft the feeling of its being origanally a voluntary effort.

CHAP. VI.

OF THE DISEASES OF THE INTERNAL EAR.

Of all the caufes of deafnefs, that which proceeds from an organic difeafe of the brain is, of courfe, the moft dangerous. In apoplectic affections, with faultering of fpeech and blindnefs, deafnefs is alfo produced by the general affection of the brain. But worft of all is the cafe where a tumor of the brain, or betwixt the cerebrum and cerebellum, compreffes the origin of the nerves †. I have, however, obferved, that a tumor in the *vicinity* of the origin of the auditory nerve, though it ran its courfe fo as to prove fatal, had rather

* Reid's Enquiry, p. 98.

† Vidit Clariff. Dom. Drelincurtius Tumorem fteatomatis confiftentia pugnique magnitudine, cerebrum et cerebellum inter, eo præcifè loco ubi conarium utrique fubfteritur choroidis plexus alæ, fpatio femeftri a fenfibili læfione, cæcitatem primo, furditatem fubinde, omnium denique fenfuum et functionum animalium abolitionem et necem ipfam intuliffe." Bonet. vol. i. p. 123. ob. 53. In Sandifort Obf. Anatom. Path. tom. i. p. 116. there is an inftance in which the auditory nerve had a cartilaginous tumor adhering to it.

a con-

a contrary effect on the organ of hearing; and while the pupil of the eye remained ftationary, and the man faw indiftinctly, he had a morbid acutenefs of hearing. This had probably been produced by the furrounding inflammation having extended to the origins of the auditory nerves. The auditory nerve often becomes morbidly fenfible, and the patient fuffers by the acutenefs of perception, or is diftreffed with the tinnitus aurium, which is, in this cafe, analogous to the flafhes of light which fometimes affect the eye in total darknefs, and which thofe experience who are totally blind or have cataract. So morbidly acute does the fentation fometimes become, that the flighteft motion of the head will excite a fenfation like the ringing of a great bell clofe to the ear *. With delirium, vertigo, epilepfy, hyfteria, the encreafed fenfibility of the organ becomes a fource of painful fenfation.

In apoplectic affections, with faultering of fpeech and blindnefs, there is alfo deafnefs; becaufe the affection of the brain is general. With a paralytic ftate of the mufcles of the face, there is a deafnefs of the correfponding ear, if the affection of the nerve be near the brain; which is explained by the ftrict connection betwixt the auditory nerve and the nervus communicans faciei. From obferving the courfe of the nervus communicans faciei through the temporal bone, and its connections in the tympanum, we underftand why, in violent tooth-ach and in the tic douleureuxe, we find the Euftachian tube and root of the tongue affected. The ear is fometimes affected by fympathy of parts: for example—from foulnefs of the ftomach and bowels; and the fame reafon may be affigned for the complaint of hypochondriacs, that they are molefted with ftrange founds. And in the cafe of inteftinal worms, we find the patient complaining of

* F. Hoffman. Confult. et Refponf. Caf. xxxix. We muft not, however, take his reafoning after what we have feen of the ftructure of the ear, that the vifcid petuita, feparated in the concha, cochlea, and labyrinth, refolved into halitus endeavouring to efcape, produces the fufurrus et tinnitus aurium.

murmuring and ringing in the ears *. Of the organic diseases of the labyrinth, there is little on record. It would appear, that the fluids become often so altered in their consistence as to prove an absolute destruction to the organ. Mr. Cline found in a person deaf from birth, that the whole labyrinth was filled with a substance like cheese.

A disease of the auditory nerve, like that of the retina in the gutta serena, is no unfrequent complaint †.

We ought, at all events, before proposing any operation on the ear, to observe whether the disease be not in the seat of the sense, and such as will not yield to any practice; otherwise, as in the more important operations when done in circumstances which preclude the possibility of success, the public is impressed with its inefficacy and danger, and we are precluded from giving relief on occasions more favourable for our operations.

Deafness, in acute fever, is a good sign; because, say authors, it argues a metastasis of the morbific matter. We should rather say, because it argues a diminution of the morbid sensibility of the brain ‡. But the surcharge of the vessels of the brain or of the auditory nerve will also produce deafness and unusual sensations in the ear; as in suppression of the menses and hæmorrhoids, in surfeit, &c. in which cases it is often preceded by vertigo and head-ach.

* Hoffmann. Med. Consult. Boerhaave. The sympathy is sometimes exerted in another way:—" Ex musices tonitru aut sola " meatus auditorii externi contrectatione, vomitus urinae incon- " tinentia". Sauv.

† Dysecoea (atonica) sine organorum sonos transmittentium vitio evidente. Cullen. Cophosis *Sauv. Cophosis* a *Paracusi* distinguitur ut *amaurosis* ab *omblyopia* respectiva. Sauv.

‡ But the difficulty of knowing when the deafness is the result of disease, or malconformation in the parts transmitting the sound to the nerve, and when in the brain and nerve, has led to more uncertainty and confusion with regard to the species and varieties of the disorders of the ear than in the eye; where the transparency of the humors assist in the definition.

There

There occurs a very curious inſtance of analogy betwixt the ears and eyes* in the following caſes:—"A certain eminent muſician, when he blew the German flute, perceived at the ſame time the proper ſound of it and another ſound of the ſame rythm or meaſure, but of a different tone. His hearing ſeemed thus to be doubled. It was not an echo; for he heard both ſounds at one and the ſame moment: neither were the ſounds accordant and harmonious, for that would have been ſweet and pleaſant to his ear. Having for ſeveral days perſiſted in his attempts, and always been ſhocked with this grating ſound, he at laſt threw his flute aſide. The day before he firſt became ſenſible of this ſtrange affection, he had imprudently walked in a very cold and damp evening, and was ſeized with a catarrh in the right ſide. Whence, probably, it aroſe that the natural tone of that ear was altered: the ſound appeared more grave, and diſſonant from that received by the left ear. Having recovered from the catarrh, the diſtinct hearing of his ear was reſtored."

Sauvage, who relates this caſe, ſubjoins another:—"Very lately," ſays he, "a foreigner came for advice in a ſimilar ſituation. He complained that when any perſon ſpoke to him, he heard the proper ſound of the voice, and at the ſame time another ſound accompanying it an octave higher, and almoſt intolerable to him. As it muſt have happened that if the accompanying ſound had preſerved the true octave above the voice, and been ſynchronous with it, the ear would have received them as one ſound, and been pleaſed with their concord: it is probable that the accompanying ſound was not in uniſon with the true. Sauvage, vol. iii. p. 352.

BOOK III.

OF THE NOSE AND THE ORGAN OF SMELLING.

OF THE SENSE OF SMELLING.

SMELLING ſeems to be the leaſt perfect of the ſenſes. It conveys to us the ſimpleſt idea, and is the leaſt ſubſervient to the others. The ſenſations it preſents to us we can leſs eaſily recall to memory; and the aſſociations connected with it are leſs preciſe and definite than thoſe of the ſenſes of hearing and ſeeing.

Animal and vegetable bodies, during their life, growth, putrefaction, and fermentation, and, moſt probably, all bodies whatever, are perpetually giving out effluvia of great ſubtility. Thoſe volatile particles repelling each other, or being diffuſed in the atmoſphere, are inhaled by the noſe, and convey to the pituitary membrane of the noſe the ſenſation of ſmell.

Immediately within the noſtrils, there are two cavities ſeparated by the boney partition, which has been already deſcribed in treating of the bones. Theſe cavities enlarge as they proceed inward, and open backward into the throat, and, conſequently, communicate with the mouth. They extend upward and ſideways into the cells of the bones of the face; and the petuitary membrane is much extended over the ſurfaces of theſe winding paſſages, and over the irregular ſurfaces of the noſe, formed by the projecting cartilages of the œthmoid and lower ſpongy bones; which, alſo, have already been ſufficiently deſcribed.

The

The cavities of the noſe lead into many cells in the bones of the face, which, though not the immediate ſeat of the ſenſe are ſubſervient to the organ by permitting a circulation of the air carrying the effluvia into contact with the nerve. No doubt theſe cavities are alſo uſeful in giving vibration and tone to the voice. The cavities of the noſe are continued upwards into the frontal ſinuſes, and into the cells of the œthmoid bone; backward and upward into the ſphenoid ſinus; and upon the ſides into the antra higmoriana or ſinuſes of the upper maxillary bones.

The membrane covering the ſurface of theſe bones is called the MEMBRANA SCHNEIDERIANA, the mucous or pituitary membrane. It is of a glandular ſtructure, or is lubricated by the mucus diſcharged by the folicules on its ſurface. This ſecretion on the ſurface of the membrane, is to defend its delicate and ſenſible ſtructure from the effects of the air, while it preſerves the ſenſibility of the ſurface and the delicate expanded nerve. It ſeems of a nature to allow the effluvia to penetrate it.

It appears to me, that a very particular proviſion has been made againſt the too powerful effect of ſmells while the membrane is inflamed, and, conſequently, in a ſtate of great ſenſibility. When the membrane is inflamed, the ſecretion is ſo altered, that the effluvia do not penetrate ſo as to affect the nerve in its ſtate of extreme ſenſibility.

We have already deſcribed the courſe of the firſt pair of nerves or the olfactory nerves, and alſo thoſe branches of the common nerves which are diſtributed to the membrane of the noſe. Theſe, it were ſuperfluous to recapitulate here. It was ſuggeſted as the moſt probable opinion, that the olfactory nerve alone is ſubſervient to theſe parts conſidered as the organ of ſmelling, and that the adventitious branches ſupply merely the common ſenſibility which the nerves beſtow promiſcuouſly over the body. This ſenſible and nervous membrane, and this glandular and ſecreting membrane, is extremely vaſcular, as it is natural, *à*

priori, to ſuppoſe; and this vaſcularity, this glandular ſtructure, and its expoſed ſtate, makes it liable to frequent diſeaſe: and, when diſeaſed, when tumors and polypi form in it, we muſt never forget the extreme thinneſs and delicacy of the ſurrounding bones, which, when they are either preſſed upon by tumors, or have their membranes eroded, are ſoon totally deſtroyed. It is with manifeſt deſign, that the organ which ſo particularly admoniſhes us of the effluvia diffuſed in the air we breathe, ſhould have been placed in the entrance to the canal of the lungs. It is, in ſome meaſure, a guard to the lungs, as the ſenſibility of the tongue guards the alimentary canal. That the humidity of the membrane either preſerves the ſenſibility of the noſe, or is a ſolvent, in which the effluvia diſſolving affect the nerves, is evident; for the ſenſe is loſt when the membrane becomes dried. The ſenſibility is alſo affected in various ways by too abundant a mucous diſcharge, or by an alteration of its natural properties; by the infarction and thickening of the membrane as in ozæna; by obſtructions preventing the current of air through the noſe, as in polypi, &c.

The acuteneſs of ſenſation in this organ is moſt probably loſt by our habits, by our relying on other ſenſes, by the inceſſant application of artificial odours to the organ. Thoſe who have believed in the variety of the human ſpecies, and the approximation of ſome tribes to the brute, dwell much on the acuteneſs of ſenſation enjoyed by negroes, and their wider noſtrils *.

* *Pallas* ſays, the Calmuck by applying his noſe to the hole of a fox or any other beaſt can tell whether he be at home or not. — See *White of Mancheſter*.

BOOK IV.

OF THE MOUTH, SALIVARY GLANDS, AND ORGAN OF TASTE.

CHAP. I.

OF THE MOUTH AND TONGUE.

ALTHOUGH it is not neceſſary to ſay, that the mouth is " betwixt the noſe and chin," that " there are " lips ſerviceable to the purpoſes of ſpeaking, eating, and " drinking ;" though it be not neceſſary to lay it down circumſtantially, that there are cheeks on the face, and a tongue in the mouth ; yet is there much important anatomy, and very uſeful knowledge neceſſary to be acquired here.

Of the TONGUE, it is only neceſſary to obſerve its form, and the terms uſed in its deſcription. The BODY of the tongue conſiſts of the muſcular fibres, with intermingled fat and cellular membrane ; and the muſcles which chiefly compoſe it, are the linguales, ſtylogloſſi, and geniogloſſi muſcles,

The BASE of the tongue is connected with the os hyoides.

The ſurface applied to the roof of the mouth is the DORSUM ; and on this ſurface there is to be obſerved a middle line, dividing the tongue into two lateral portions ; a diviſion which is very accurately preſerved in the diſtribution of the blood veſſels and nerves of either ſide. On the dorſum, towards the baſe, the ſurface is rough with the papillæ maximæ and foramen cæcum Morgagni *. Theſe papillæ are like ſmall glands ſeated in little ſuperficial foſſulæ, ſo that their broad muſh-

* Adverſar. Anat. VI. Animad. XCIII.

room-

room-like heads alone are ſeen; but they are connected with the bottom of the foſſulæ by ſhort ſtems or necks. This is conſidered a glandular apparatus. The foramen cæcum is, in truth, only an enlarged apparatus of the ſame kind, for, in the bottom of this foramen, many glandular papillæ ſtand up; and in its bottom ſmall foramina have been obſerved, which are generally conceived to be the mouths of ſmall ſalivary ducts. Morgagni himſelf however ſeems only to have ſeen a ſmall duct opening into this foramen in one ſubject of many which he examined. In *Haller's opuſcula* there is a diſſertation on the *Duct of Coſckwizianus*, which was ſuppoſed to carry the ſaliva from the ſublingual gland to the middle of the tongue, and alſo into the throat it turns out to be a vein only. It is curious to obſerve the neceſſity he diſcovered for theſe ducts, when he thought he had found them *. This ſecreting mucous ſurface begins here, towards the root of the tongue, to reſemble the glandular ſtructure of the œſophagus, which by bedewing the ſurface of the morſel, fits it for an eaſy paſſage through the gullet. To me it ſeems that this roughneſs of the root of the tongue is a proviſion for the detenſion of the ſapid particles, and the prolonging of the ſenſations of taſte.

The PAPILLÆ peculiar to the human tongue, are divided into four claſſes. 1. Theſe larger papillæ upon the root of the tongue are the truncatæ; and they are often ſtudded on the dorſum of the tongue in a triangular form. 2. The fungiformes are obtuſe papillæ found more forward on the tongue; they are little hemiſpherical tumid papillæ, or of a cylindrical ſhape, with an obtuſe apex. Theſe are interperſed among the 3d diviſion, the moſt numerous and univerſally prevalent papillæ, viz. villoſi or conicæ. 4. The more important papillæ, however, are thoſe which are endowed with peculiar ſenſibility to ſapid bodies; they are to be diſtinguiſhed by their ſuperior red-

* Vater, who injected theſe ducts, found them terminating in a gland near the os hyoides; and his opinion was, that they had even a connection with the thyroid gland. Heiſter was of the ſame opinion.

neſs

nefs and brilliancy upon the point and edges of the tongue.

The tongue is invefted with the cuticle and rete mucofum, like the fkin in other parts. The lower furface of the tongue is fimilar to the general lining membrane of the mouth, being a villous and fecreting furface. It is reflected off upon the bottom of the mouth. It forms here the frenulum linguæ. This ligament feems evidently intended to limit the motion of the point of the tongue backwards. I believe a very falfe opinion has much prevailed, that the fhort nefs of this ligament, or its being continued too far forward toward the point of the tongue, prevents the child from fucking. The tongue, as I conçeive, would fufficiently perform the neceffary action on the mother's nipple, although its lower furface were univerfally adhering to the bottom of the mouth. But, obferve the bad confequences which may arife from cutting this frenulum, from the obftinate importunity of the nurfe, or the weaknefs of a furgeon. The ranine vein or artery which runs near it may be cut, and the child will continue fucking and fwallowing its own blood; and children have actually died, and the ftomach has been found diftended with blood! But there is another more dreadful accident from this cutting of the frenum linguæ. A child, fays Mr. Petit, whofe frenum had been cut almoft immediately after its birth, was fuffocated and died five hours afterwards. They believed that the operation was the caufe of the child's death; they fent for me to open the body. I put my finger into its mouth, and I did not find the point of the tongue, but only a mafs of flefh which ftopped up the paffage from the mouth into the throat. I cut up the cheeks to the mafeter mufcles, to fee what had become of the tongue; I found it turned like a valve upon the fauces, and the point actually fwallowed into the pharynx. "Some time after," continues Mr. Petit, "I was called to the child of Mr. Varin, Sellier du Roi, whofe frenum they had cut two hours after its birth, and who, a little after, had fallen into the fame fituation with the child I have now mentioned, and was nearly

nearly ſuffocated. My firſt care was to introduce my finger, the tongue was not, as yet, entirely reverſed into the throat. I brought it back into the mouth; in doing which, it made a noiſe like a piſton when drawn out of its ſyringe." Mr. Petit waited to find the effect of its ſucking, and, after hearing the action of deglutition for ſome minutes, the child fell again into the ſame ſtate of ſuffocation. Several times he reduced the tongue, and, at laſt, contrived a bandage to preſerve it in its place; but, by the careleſſneſs of the nurſe, the accident recurred, and the child was ſuffocated during the night.

CHAP. II.

OF THE SALIVARY GLANDS.

THE ſources of the ſaliva are very numerous; the parotid glands or ſuperior maxillary gland, and focia parotidis; the inferior maxillary or ſubmaxillary glands; the ſublingual glands; and (according to the opinion of many) the glandular folicules of the root of the tongue: the palate, and even the buccinales and labiales, or glands of the cheeks and lips, are alſo to be enumerated, as ſources of ſaliva.

The PAROTID GLAND, as its name implies, is that which lies near to the ear. It is the largeſt of the ſalivary glands; and it is of much importance for the ſurgeon to obſerve its extent and connections. A great part of it lies before the ear, and betwixt the ear and jaw. It extends over the maſſeter muſcle, and upward to the zygoma. But there is alſo a great part of it which lies below the tip of the ear, and betwixt the angle of the jaw and the maſtoid proceſs. Its ſurface is unequal, and compoſed of little maſſes or lobules of gland, united by a cellular membrane. The duct of this gland was diſcovered by Needam, and afterwards by Steno: it is very often called Steno's duct. When it

it is injected with quickfilver, the branches are feen diftributed in a moft beautiful and minute manner amongft the lobuli of the gland, and fimilar to the branching of veins. Thefe branches have a direction upward, and unite into a trunk, which paffes from the upper part of the gland acrofs the cheek over the origin of the maffeter mufcle: it then pierces the buccinator mufcle, and opens upon the inner furface of the cheek, oppofite to the fecond dens molaris. This duct has ftrong white coats; but, although the mouth of the duct is very fmall, the duct itfelf is dilatable to a great fize, fo that tubes of a confiderable fize have flipt into it, and been buried in the body of the gland.

The SOCIA PAROTIDIS is a fmall gland, (which, however, is by no means conftant), feated on the upper fide of the duct of the parotid gland, and juft under the margin of the cheek-bone. It opens by a leffer duct into the great duct of Steno. Sometimes, however, inftead of one confiderable gland, there are feveral fmall ones, feated in the courfe of the great duct, and opening into it by feveral minute ducts.

OF THE SUBMAXILLARY AND SUBLINGUAL GLANDS. The fubmaxillary gland is of a regular oval figure; it lies on the tendon of the digaftric mufcle, and is defended by the angle of the lower jaw, while it is generally connected with or involves the root of the facial artery. It is regularly lobulated; and its duct paffes forward between the geniogloffus and mylohyoideus, and under the fublingual gland. The openings of the fubmaxillary ducts, or ducts of Wharton, are very eafily diftinguifhed. They open under the tongue very near each other on each fide of the frenum lingæ; fo that they appear as if tied down by the frenum. When thefe are excited to difcharge their fluids, they become a little erected, their patent mouths are feen diftinctly, and the tortuous courfe of their canal in the bottom of the mouth may be obferved.

The SUBLINGUAL GLAND is of a flat and elongated form; it lies clofe under the tongue between the genio-

hyo-gloſſus and mylo-hyoideus muſcles. It is the ſmalleſt of the three great ſalivary glands. The two ſublingual glands ſtretching cloſely under the tongue, they are ſeparated from the mouth only by the membrane of the mouth. They have no large duct, but open by ſmall lateral ducts, with looſe pendulous mouths upon the lower ſurface of the tongue. Beſides the leſſer glands, which every where are found under the lining membrane of the mouth, Heiſter, Verdier, and M. de Bordeu, have deſcribed a glandula molaris, ſeated betwixt the buccinator and maſſeter muſcles.

From the general ſurface of the lips, tongue, cheek, and palate, there is a fluid exhaled. This exhaling ſurface, and all thoſe glands, are excited to action by the ſame ſtimulus with the membrane of the mouth. The ſaliva moiſtens the ſurface of the mouth, aſſiſts in manducation, and preparing the food to be ſwallowed and acted upon by the ſtomach, and accelerates digeſtion. As the mouth is an exhaling ſurface, ſo is it an imbibing and abſorbing ſurface.

CHAP. III.

VELUM PALATINUM; UVULA; ARCHES OF THE PALATE; AND AMYGDALÆ.

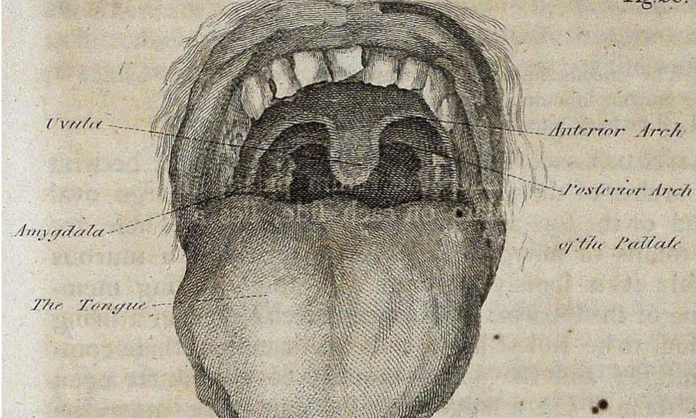
THE VELUM PENDULUM PALATI is the vaſcular and fleſhy membrane, which, hanging from the bones of the palate, divides the mouth from the fauces and throat. It is not a ſimple membrane, but has betwixt its laminæ many glands, which open upon its ſurface by little patent folicules, and is thickened and ſtrengthened by muſcular fibres: ſo that it is more of a fleſhy partition, ſtretching backward and eking out the palate, than a hanging membrane.

The edge of the velum palati is not ſquare, but turned into elegant arches; and, from the middle of the arches

arches of the palate, hangs down the UVULA, ſo named from its reſemblance to a grape. It is a large, ſoft, and glandular papilla, peculiarly irritable and moveable, having in it muſcular fibres, and hanging from the moveable ſoft palate. It ſeems to hang as a guard over the fauces, and, by its ſenſibility, in a great degree governs the operation of theſe parts. It is part of the organ of the voice.

The ARCHES OF THE PALATE OR FAUCES deſcend on each ſide from the velum palati. They are muſcular fibres, covered with the ſoft vaſcular and folicular membrane of the fauces *. There are two on each ſide. Theſe arches ſtand at ſome diſtance from each other, ſo that the iſthmus of the fauces reſembles the double-arched gateway of a citadel, or the arched roof of a cathedral, with the uvula hanging as from the central union of four ſemicircular arches.

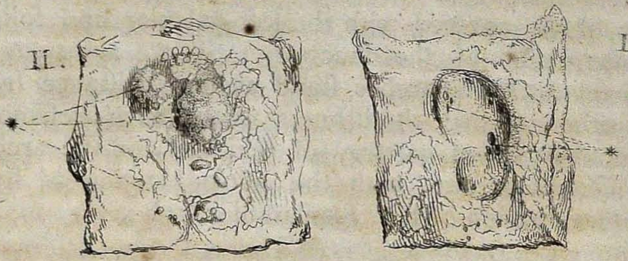
Fig: 20.



Behind the ſoft palate is the opening of the noſe backward into the throat. Now, the uſe of the velum is that in ſwallowing it may be drawn up like a valve

* See Vol. I. Conſtrictor Iſthmi fauſcium and Palato-pharyngeus.

upon the posterior opening of the nose; and there being, at the same time, an action of the arches of the palate, the whole is brought into a funnel-like shape, directing the morsel into the pharynx and gullet. In this action, the direction of the food assists, but, in vomiting, the valvular-like action of the velum is not so accurate; and often the nose is assailed with the contents of the stomach. The velum also is a principal part of the organ of the voice.



I. The membrane with the amygdalæ seen on the outside—* the mucous folicules.

II. The back part of the same—* the Amygdalæ.

AMYGDALÆ. Under the velum palati, and betwixt the arches of the palate on each side, lies a large oval gland of the size and shape of an almond. These are the tonsils or amygdalæ. The amygdala is a mucous gland: it is loosely covered with the investing membrane of these parts: its surface is seen, even in a living person, to be full of large cells like lacunæ; these communicate; and the lesser mouths of the ducts open into them.* On a narrower inspection of the amygdala I describe its structure thus: within the arch of the palate, and before the arch of the fauces, there is a fossa of an oval shape, and on the surface of the membrane a number of cells open like the mouths of veins. These do not appear to me to communicate. When the arches and the amygdala are dissected out behind these holes we feel a gland, as it were one solid body; but on further dissection from behind, the cellular mem-

membrane being taken away, inſtead of one large gland there appear a number of leſſer ones. Theſe glands diſcharge their ſecretions into the oblique paſſages which are ſeen on the membrane of the throat, and from theſe lacunæ the mucus is preſſed out when the morſel is preſſed backward. From this naturally looſe texture, and from its being a vaſcular and ſecreting body, expoſed to the immediate viciſſitudes of weather, the amygdala is often inflamed, and greatly impedes the action of the ſurrounding muſcular fibres in the action of deglutition. The uſe of the amygdala is evidently to lubricate the paſſage of the throat, and facilitate the ſwallowing of the morſel; and, for this reaſon, are the mouths of its ducts cellular and irregular, that they may retain the mucus until ejected by the action of deglutition. In this operation, the amygdalæ are aſſiſted by numerous leſſer glands, which extend all over the arches of the palate and pharnyx. But theſe are parts which come again to be recapitulated, as introductory to the account of the ſtructure of the œſophagus and ſtomach, in the ſucceeding part of the work.

CHAP. IV.

OF THE SENSE OF TASTING.

ON the ſurface of the tongue are to be obſerved many papillæ *. In theſe the extremities of the guſtatory nerve are expanded, and they are the ſeat of the ſenſe of taſting. Theſe papillæ are in the true ſkin of the tongue, and are extremely vaſcular. They are covered by the rete mucoſum, and a very fine cuticle, and indeed they have much reſemblance to the papillæ of the ſkin; while, betwixt theſe papillæ, there is a

* Albinus Ann. Acad. lib. 1. cap. xv.

fleece or down bearing a perfect analogy to the vili of the skin. The papillæ, which are the organs of taste, are to be seen on the point and edge of the tongue, and consist of a pretty large vascular soft point which projects from an opaque and white sheath. If we take a pencil and a little vinegar, and touch or even rub it strongly on the surface of the tongue, where those papillæ are not, the sensation only of a cold liquid is felt; but when you touch one of these papillæ with the point of the brush, and at the same time apply a magnifying glass, it is seen to stand erect and rise conspicuously from its sheath, and the acid taste is felt to pass as it were backward to the root of the tongue. The exquisitely sensible papillæ are placed only on the point and edge of the tongue; for the middle of the tongue is rough, and scabrous, not to give the sensation of taste, but to force the sapid juices from the morsel, or break down the solids against the roof of the mouth, and assist in their solution. The more delicate and vascular papillæ would be exposed to injury if situated on the middle of the tongue. Before we taste, the substance dissolved in the saliva flows over the edges and point of the tongue, and then only comes in contact with the organ of taste.

It would appear, that every thing which affects the taste must be soluble in the saliva; for without being dissolved in this fluid, it cannot enter readily into the pores and inequalities of the tongue's surface.

A curious circumstance, in the sense of taste, is its subserviency to the act of swallowing. When a morsel is in the mouth and the taste is perfect, our enjoyment is not full: there follows such a state of excitement in the uvula and fauces, that we are irresistibly led to allow the morsel to fall backward, when the tongue and muscles of the fauces seize upon it with a voracious and convulsive grasp and convey it into the stomach.—The measure of enjoyment is then full. This last short-lived gout is the acmè. Were not this appetite of the throat and uvula connected with the action which impels the food into the stomach, the

com-

complete enjoyment of the ſenſe of taſte alone would ſatisfy and would have rendered unneceſſary the diſguſting practice of the Roman Gourmand who forced himſelf to vomit that he might reſume the enjoyment of eating. But as it is, the connection of the ſtomach and tongue is ſuch, that the fullneſs of the ſtomach precludes the further enjoyment of the ſenſe of taſte. The ſenſes of ſmelling and taſte have their natural appetites or reliſh; but they have alſo their acquired appetites, or delight in things which to unſophiſticated nature are diſagreeable: ſo that we acquire a liking to ſnuff, tobacco, ſpirits, and opium. "Nature, indeed, ſeems ſtudiouſly to have ſet bounds to the pleaſures and pains we have by theſe two ſenſes, and to have confined them within very narrow limits, that we might not place any part of our happineſs in them; there being hardly any ſmell or taſte ſo diſagreeable that uſe will not make it tolerable, and at laſt, perhaps, agreeable; nor any ſo agreeable as not to loſe its reliſh by conſtant uſe. Neither is there any pleaſure or pain of theſe ſenſes which is not introduced or followed by ſome degree of its contrary which nearly balances it. So that we may here apply the beautiful allegory of the divine Socrates: that although pleaſure and pain are contrary in their nature, and their faces look different ways, yet Jupiter hath tied them ſo together, that he who lays hold of the one draws the other along with it."

BOOK V.

OF THE SKIN AND OF THE SENSE OF TOUCH.

OF TOUCH AND OF THE SKIN.

By the ſenſe of touch we perceive ſeveral qualities, and of very different kinds: hardneſs, ſoftneſs, figure, ſolidity, motion, extenſion, and heat and cold. Now, although heat be a quality, and cold the privation of that quality, yet in relation to the body, heat and cold are diſtinct ſenſations. But in a more preciſe acceptation of the term, the ſenſe of touch is ſaid to be the change ariſing in the mind from external bodies applied to the ſkin, and more eſpecially to the ends of the fingers. They might have added the tip of the tongue, which is the ſeat of the moſt exquiſite ſenſe.

To underſtand the organization adapted to this ſenſe, we muſt premiſe, in a ſhort view, the ſtructure of the ſkin.

OF THE SKIN.

The ſkin is deviſible, by the art of the anatomiſt, into four laminæ or membranes, diſtinct in texture and appearance, and uſe, viz. the *cuticle*, or *epidermis*; the *corpus mucoſum*, or reticular tiſſue; the *cutis vera*, *dermis corium*, or true ſkin: but from this laſt there is ſeparated a *vaſcular membrane*, below which is the ſurface of the true ſkin; laſtly, we may enumerate the tela cellulosa *.

The CUTICLE OR EPIDERMIS, OR SCARF SKIN, is the moſt ſuperficial lamina of the ſkin: it is a tranſ-

* Andreas Bonn. de Continuationibus Membranarum in Sandifort Theſaur.

parent

parent and insensible pelicle which serves, in some degree, to resist the impression of external bodies on the surface of the body, and to blunt the otherways too acute sensation of the cutis vera *. In man it is very thin, unless in those parts which are exposed to the contact of hard bodies, as the palms of the hands and soles of the feet. The thickness of the cuticle there, however, is not altogether the effect of labour and walking, but there is even in the early fœtus a provision for the defence of the skin in these places. When the cuticle is drawn from its foot the sole is white, opaque, and thick, whilst, in the leg, it is transparent and more delicate †. This is particular, that by labour or continued pressure on the cuticle it does not abrade and become thin and tender, but thicker, harder and the part more insensible, so as even to acquire a horny hardness and transparency. Of this we have an example in the hands of smiths and other workmen, and in a remarkable manner in the feet of those who have been accustomed to walk bare-foot on the burning sands. It is thus a protection to the foot in a state of nature. But if the skin be too much or too quickly exerted, instead of forming additional layers of cuticle, a serous fluid is thrown out from the true skin, which separates the cuticle in blisters; and this over action of the skin will throw off the cuticle in consequence of the irritation of plasters or cataplasms, scalding water, in exanthematous diseases, in erysipelas and mortifications, &c. ‡. When the foot comes to be unnaturally pinched in shoes the hard leather works perpetually on a point of the toes and blisters the feet; but if in a lesser degree and longer continued it excites the formation of cuticle in the skin below, which thrown outward by succeeding layers of cuticle, at last forms a corn or clavus, and which like a

* It is unaccountable that so great a man as Morgagni could suppose the cuticle to be the mere effect of air and pressure on the surface of the true skin. Adversar. Anatom. III. 3.

† *Albini. Annot. Acad.*

‡ *Albini. Annot. Academ.* lib. i. cap. i. Bonn. loc. cit.

small

ſmall nail, has a broad head with a conical point ſhooting into the tender ſkin *.

The cuticle is perforated by the extremities of the perſpiring and abſorbing veſſels, and by the ducts of the glands of the ſkin and by the hairs. Indeed, when the ſmall pores of the ſkin or foramina are examined narrowly, the cuticle is ſeen to form ſheaths which enter into them, and which, when torn out, are like little tubes having a perforated point; for when, by maceration, the cuticle is ſeparated from the ſkin, as we draw it off we ſee little proceſſes of the cuticle, which enter into the pores of the ſkin.

In the dead body the cuticle may be ſeparated by permitting putrefaction to go on, and therefore the ſkin is put in maceration †: Ruyſch ſeparated it by extending a portion of ſkin and pouring boiling water upon it ‡. Veſalius and Malpighi practiſed the coarſer way of carrying a red hot iron near the ſkin.

Mr. Cruickſhanks enumerates three claſſes of proceſſes of the cuticle: there appear evidently two. The firſt lines the pores through which the hairs paſs: theſe are the longeſt. The ſecond claſs is eaſily diſtinguiſhed on the inſide of the cuticle, which covers the palms of the hands or ſoles of the feet, or indeed on any part of the cuticle; and they appear in regular order on thoſe parts of the cuticle which correſpond with the parallel or ſpiral ridges of the cutis: theſe enter into the pores of the true ſkin. The ſurface of the cuticle is uniform next the ſkin; but, on the outer ſurface, it is rough and ſquamous. Theſe ſquamæ are the portions of the cuticle, which, breaking up, are rubbed off; for there is a perpetual change, by the formation of new cuticle under the old, and the abraſion or diſquamation of the old ſurface.

When I ſay that the cuticle is uniform I muſt not forget to ſpeak of the regular lines obſervable on both its ſurfaces.

* De clavo pedis, vide Albinus, Acad. Annot. lib. vi. cap. vi. et vide tab. ii. fig. 1.

† Santorini Obſerv. Anat. cap i. § i.

‡ De hum. C. fabrica, lib. ii. c. 6.

The

The ulcerative procefs has no power over the cuticle, fo that when the matter of an abfcefs has reached the cuticle, its progrefs is ftopt until the cuticle is burft by the diftention. This is the reafon of the greater pain of abfceffes in the foles of the feet and palms of the hand, where the cuticle is very ftrong *.

OF THE STRUCTURE AND GROWTH OF THE NAILS.

The NAILS are naturally connected with the cuticle, for they remain attached to it: in exanthematous difeafes, when the cuticle exfoliates, the nails are alfo pufhed off; and in death they both feparate from the true fkin by maceration and beginning putrefaction. The nails are to give firmnefs and refiftance to the points of the fingers. Although they take a very univerfal adhefion, it is chiefly from the root that they grow and fhoot out to the point of the fingers, to which they adhere firmly. Over the root of the nail the cuticle projects, and under it the rete mucofum is extended; and under this, and defended by it, are the papillæ of the fkin.

Like the cuticle, the nails are without veffels or fenfation: they are undergoing a perpetual growth, by thin roots, and are worn down by labour. When cherifhed, they grow to an amazing length, and curve a little over the points of the fingers; and ferve in fome nations as a moft unequivocal fign of high rank and idlenefs. By difeafe, I have feen very large crooked horns projecting from the ftool of the nail of the toes. They were thus monftroufly encreafed by fuperimpofed laminæ fhoved off by the more recent ones. It was fuppofed that the nails were formed by the extremities of the tendons, which extending beyond the flefh were dried and hardened †; and the celebrated Albinus defcribes the nail as formed by the converfion of the papillæ which lie under it ‡: they are generally conceived to be a continuation of the epidermis §.

* See Hunter on Blood and Inflam. p. 469.

† *Riolanus.*

‡ Annot. Acad. vol. i. lib. ii. cap. iv.

§ Winflow.

But

But ſaying that the nails are continuations of the cuticle, though true, is ſaying nothing.—We cannot believe, even on the authority of Albinus, that the nervous filaments which lie faciculated under the nail are converted into the nail, merely becauſe the under ſurface of the nail is reticulated like theſe filaments. For it is evidently reticulated like the ſoft filaments, in order to give lodgment to them, to have a correſponding ſurface with them.

The nails differ from the cuticle in not ſcaling or exfoliating like it, but in growing from a root like a hair.

OF THE HAIRS.

The hairs grow from a bulbous root, ſeated in the cellular membrane. This bulb is vaſcular, and has connection, by veſſels, with the cellular texture. It conſiſts of a double membrane; the outer is a kind of capſule which ſurrounds the other, and ſtops at the pore in the ſkin, and does not form part of the hair. Betwixt theſe capſules, there is a cellular tiſſue, and the ſpace is commonly found filled with a bloody fluid. In the bottom of the inner ſac, there is a ſmall body, called monticule by Duverney, from which the hair is ſeen to ariſe; and if this is left when the bulb of the hair is pulled out, the hair will be regenerated.

The root of the hairs, ſays Mr. Winſlow, is covered by a ſtrong white membrane, which is connected with the ſkin and cellular membrane. Within the root, there is a kind of glue, ſome fine filaments of which advance to form the ſtem, which paſſes through the ſmall extremity of the bulb to the ſkin. As the ſtem paſſes through the root, the outer membrane is elongated in form of a tube, which cloſely inveſts the ſtem and is entirely united with it. And many authors agree, that the hair does not perforate the cuticle, but takes from it merely a vagina which accompanies it *.

* Vide quæ de hoc *Albinus* Animadvertit. Acad. Annot. l. vi. cap. ix. and *Morgagni* Adverſar. et Epiſt. An. iii. § 4.

The

The hair ferves as a diftinction in the human tribes. The European has the longeft hair, next to him the Afiatic, then the American, and laftly the African *. A common opinion is entertained that hair on the body is a mark of ftrength; but I have obferved that our famous boxers, when in high condition, are fmooth, fair, and clear in the complexion of their bodies; while men of a dark fallow hue are generally hairy on the trunk and fhoulders. Betwixt hair and wool, or betwixt the hair on different parts of the body, there is no diftinction in the anatomical ftructure. In the growth of hair and wool, however, there is a difference. They are both produced annually; but wool is fhed at once and leaves the animal bare, whilft the hair falls off gradually, and the young and the old hairs are together growing at the fame time. Hair is of uniform thicknefs in its whole length; whereas wool is variable in the thicknefs of its filament;—further it has been found †, that the thicker part grows during the warmer times of the feafon; that it is thicker in fummer, and finer in the fpring and autumn. This fhows us how the fleece becomes coarfe and hairy in a warm climate.

RETE MUCOSUM.

The rete or corpus mucofum, or Reticulum Malpighi, lies betwixt the cuticle and the furface of the true fkin. It is a mucous layer, pervaded by the little fibrillæ paffing betwixt the fkin and cuticle. I confider it as a foft bed to envelope and preferve the papillæ of the fkin, and as intended to become cuticle in due fucceffion. It was confidered, by Albinus, as of a nature adapted to imbibe the fluids through the cuticle, and as a production of the epidermis. M. Meckel believed

* Mr. White of Manchefter tells he has feen a lady with hair fix feet in length:—a Pruffian foldier whofe hair trailed on the ground.

† By Dr. Anderfon. See White of Manchefter on the gradation of man.

it to be only a mucous fluid, inſpiſſated into the form of a membrane; and that it was diſſolved by putrefaction, while the ſkin and cuticle remained firm. It is the ſeat of colour in the ſkin, and is of a white tranſparency in the albino, and in the inhabitants of temperate climates. It is black in the negro; copper coloured in the mulatto; yellow in the Egyptian *. It is ſuppoſed to preſerve the negro from the heat of the climate; but I conceive that the power of reſiſting the baneful effects of warm climates, muſt be looked for in other conſtitutional peculiarities: for certainly a ſurface which abſords the light muſt produce heat more rapidly than a white one, which repels it †. The ladies know that the effect of a black veil, in intenſe ſun-ſhine, is to ſcorch the cheeks. The rete mucoſum changes its ſhades of colour in Europeans, from the effect of light; but this tanning ſeems to have no ſtrict reſemblance to the permanent colour of the negro ſkin. It ſoon reaches its maximum by the influence of the ſun, and ſoon wears off again. And this degree of blackneſs does not reach the offspring ‡. When the rete mucoſum is deſtroyed by ulceration it is imperfectly regenerated, and does

* Malpighi de ſede negridinis in Ethiope. It has appeared to me that there was a great deal of colour in the cuticle of the negro, and ſo Morgagni. "negricante et fuſco colore infectas." Adverſar, II. Animad. IV. See alſo Blumenbach de generis humani Varietate. The colour of the ſkin belongs to tribes and is only in a certain degree affected by climate. *Humboldt*, Eſſaie Politique ſur la Nouvelle Eſpagne, obſerves that climate, which has ſuch effect on Europeans, has little or none on the Indian complexion; tribes of a temperate climate are darker than thoſe inhabiting a province leſs cool and temperate. The Indians on the tops of the Andes are as dark as the inhabitants of the plains. Humboldt alſo aſſerts (contrary to Volney) that, in the provinces of Spaniſh America the children of Indians are copper coloured from the moment of their birth.

† Prieſtley's Experiments.

‡ The Gradation in Man, by Charles White of Mancheſter.—Some have ſaid that extreme cold alſo tanns the ſkin, as the Laplanders, the Eſquimaux Indians, and Greenlanders, are dark; oppoſed to this, we find the Finlanders and Norwegians fair beyond other Europeans. There is much in the habits of life: a painter will not find his carnation tints amongſt the poor—nor in the ſkin of a Highlander; yet where ſo pure as in a Highland lady?

poſſeſs

not poſſeſs its former colour. In a negro the inner ſurface of the rete mucoſum is blacker than the outer ſurface; the inner ſurface of the cuticle is ſofter and darker than the outer ſurface*. Mr. White argues, that if this blackneſs were the effect of the ſun, that part moſt expoſed would be the blackeſt. But though I agree with him in thinking that the blackneſs of the negro is not owing to climate, yet I ſee this argument of his is incorrect; for it is not the direct influence of the ſun which tanns; no ſuch effect comes of expoſing dead ſkin; it is the excitement of the living vaſcular ſurface in the formation of new matter, or the diſcharge of colouring matter into the rete mucoſum.

While the rete mucoſum has its peculiar uſe of defending the delicate ſurface of the papillæ of the ſkin, I conceive it to be undergoing a perpetual change; to be thrown off in ſucceſſion from the vaſcular ſurface of the ſkin, and in its turn to form the cuticle by its outer layers. The inner ſurface of the rete mucoſum is ſofter and more pulpy, the outward ſurface more allied to the cuticle, which gives occaſion to Mr. Cruickſhanks to ſay it is double.

Under the rete mucoſum, and on the ſurface of the ſkin, there is a ſoft vaſcular membrane, which is ſtill above the porous and glandular true ſkin. It was firſt demonſtrated by injections in ſubjects who had died of ſmall-pox, and is alſo ſo much ſtrengthened by other inflammatory actions of the veſſels of the ſkin, as to be capable of demonſtration. It was at firſt ſuppoſed that this vaſcular membrane was the rete mucoſum ſucceſsfully injected; but afterwards it was found, that this vaſcular membrane exiſted independently of this rete mucoſum †. Mr. Cruickſhanks conceives that it is cuticle in

* Mr. White of Mancheſter, on the gradation of man, in the plate from a preparation of Mr. Cruickſhanks. For opinions regarding the cauſe of colour in the ſkin, ſee *Albinus d. ſede et cauſa Coloris Æthiopium Sugd. Batav.* 1737.—*Haller Element. Phyſiolog vid page* 20.—*Blumenbach de generis humani varietate nativa Gottingæ*, 1795, page 122, and note.

† Mr. Baynham, who diſcovered this vaſcular ſurface, conceived that he had injected the rete mucoſum. Ruyſch and others mentioned by

in its ſtate of formation, and that the rete mucoſum is in fact a cuticle advancing to the ſtate of perfect maturation. But I ſhould rather believe that this is a vaſcular ſurface, not changeable, nor loſing its vaſcularity, to be thrown off in form of rete mucoſum; but, in itſelf, the organized ſurface, which is to form the rete mucoſum, and which excretion does in ſucceſſion become cuticle. This vaſcular ſurface of the ſkin, for ſuch I muſt ſuppoſe it, although it be capable of being ſeparated by long maceration and putrefaction, into ſomething like a diſtinct membrane, is the ſeat of the ſmall-pox puſtule, and probably of all other cutaneous diſeaſes *.

There are three laminæ above the true ſkin, diſtinguiſhed by their character; the cuticle, the rete mucoſum, and the vaſcular membrane: but as ſome have divided the rete mucoſum into the lamina, Mr. Cruickſhanks has ſeparated two vaſcular layers from the ſurface of the ſkin. They, who are fond of ſuch minute ſubdiviſions, may thus enumerate five laminæ or membranes, before coming to the porous ſurface of the true ſkin.

OF THE TRUE SKIN.

The true ſkin is the denſe, elaſtic, and vaſcular membrane which is under theſe outer laminæ, already treated of. It conſiſts of a net work of firm filaments, having in their protection ſebaceous glands, exhalent and abſorbent veſſels, nerves, the paplilæ or organized extremities of the nerves, and the roots of the hairs †. While it has firmneſs, ſtrength, and elaſticity to defend

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by Albinus, ſuppoſed they had injected the cuticle when moſt probably they had torn off the vaſcular membrane, or as *Albinus* alledges, Acad. Annot. lib. vii. c. iii. in taking off the cuticle they had torn up the vaſcular papillæ along with it.

* Of the ſlough of the ſmall-pox puſtule, ſee Dr. Adams's Morbid Poiſons. Appendix.

† Bonn. Camper.

the

the body ; it is alſo an organized ſurface, as important in its function, and the healthy action of the ſyſtem depending upon it nearly as cloſely as on the action of the lungs and ſurface of the inteſtines.

The ſkin is denſe on the outer ſurface, while the internal layers are looſe, and gradually degenerate into the cellular ſubſtance. Our ſoldiers and ſailors have a a way of marking their ſkins with gunpowder or with vermilion, which is indelible. They prick the ſkin and inſert the colouring matter into it, where it remains without producing inflammation, and unabſorbed. But this is no proof of the unchangeable nature of the ſkin as regards its colour, or whatever elſe may diſtinguiſh the nations and tribes of man *.

We have to attend to the pores and vili of the ſkin : on narrowly obſerving the ſurface of the ſkin, we find it irregularly porous. Theſe are the ducts of ſebaceous glands, which are lodged in the ſkin. They tranſmit the hairs alſo, and are the perſpiring and, probably, the abſorbing pores ; or, at leaſt, within theſe larger pores the abſorbing and tranſpiring veſſels terminate. Theſe pores are moſt remarkable about the noſe, mouth, palms of the hands, and ſoles of the feet. Into theſe pores of the true ſkin, as we have mentioned, little ſheaths of the cuticle enter, and through theſe ſheaths the perſpiring matter muſt conſequently eſcape : but perſpiration is the action of living parts ; in death, the action of the perſpiring veſſels ceaſing, the pores of the cuticle are no longer pervious to the fluids, and there is no perſpiration or exudation through them.

* I allude to the ingenious eſſay of the *Rev. S. S. Smith* of the American Philoſoph. Society, on the cauſes of the variety in the human complexion and colour.

OF THE ORGAN OF TOUCH *.

The vili of the ſkin project above its ſurface, like the pile of velvet. They vary much in ſize, and are in ſome places very much prolonged. They conduct the ſenſible extremities of the cutaneous nerves to form the organ of the ſenſe of touching †; and, probably like the papillæ of the tongue, they ſuffer an erection and excitement preparatory to the reception of the impreſſion. I am inclined to believe that they ſuffer this occaſional preparation like the papillæ of taſte, from their reſembling them in ſtructure. I ſee that theſe ſentient filaments are very vaſcular at their extremities. When the hand is minutely injected, and there ſeems a general bluſh of redneſs over it; when the cuticle is taken off and we examine the vili with a powerful magnifying glaſs, their extremities are ſeen bulbous and red. We know that even in nerves there is no ſenſibility without blood be ſupplied, and I look upon this high degree of vaſcularity as a proviſion for great ſenſibility.

Another circumſtance is worthy of obſervation: in the interſtices of the ridges of the cuticle there is a ſoft matter in which theſe vili lie ſecure, yet ready to receive the impreſſion made on the inſenſible cuticle.

Of the nature of the ſenſation conveyed by the nerves of the ſenſe of touch we are as ignorant as of that conveyed by the other nerves. We are accuſtomed to conſider this as an inferior ſenſe for no better reaſon than that it is more common to the ſurface of the body, whereas it is the moſt important, and that which miniſter to the other ſenſes and to our neceſſities moſt of all:—it is the ſenſe neceſſary to the exiſtence of every living creature.

In concluding this account of the anatomy of the ſkin it may be expected that I ſay ſomething of its function. What I have to ſtate on this head muſt be very

* Albinus Diſſertatio de Sede et Cauſ. Color. Æthiop. Malpighi, et Exercit. de Tact. Organ.

† Vide de Papillis Cutis, *Albini*, Ac. Annot. lib. vi. c x. and Ruyſch.

ſhort.

ſhort. The perſpired matter from the ſkin conſiſts of water and carbon; an acid has alſo been diſcovered, independent of the carbonic acid, which is probably formed by the union of carbon with the oxygen of the atmoſphere. But independent of chemical teſts, we muſt conclude that as perſpiration has taſte and ſmell there muſt be ſome matter yet undiſcovered which is inceſſantly excreted from the ſurface *. It would be well perhaps to diſtinguiſh, if it be poſſible, the function of the ſkin as a ſurface in connection with the general œconomy, from the diſcharge of glands for a different purpoſe ſeated in the ſkin. It is from the glands I imagine that an oily matter is diſcharged upon the ſurface *.

Whatever other purpoſe the function of the ſkin may ſerve this very evident one is ſerved by ſweat, viz. according to the activity of the circulation is the heat of the body, and according to the activity of the circulation is the perſpiration in health. By this perſpiration, and the change of the perſpired fluid unto vapour, the heat of the body is carried off. In a cold atmoſphere, perſpiration ceaſing, the vital heat is retained; in a warm atmoſphere, the perſpiring action being excited, the heat of the body is prevented or carried off.

The mind is kept ſuſpended betwixt what we owe to the moſt reſpectable authority †, and the difficulty we have in believing how it can happen, that men can exiſt in a temperature exceeding that of boiling water.

The authorities are contradictory in regard to the abſorption by the ſurface, unaided by friction, abraſion or ulceration ‡.

The more important function of the ſurface is to be contemplated in its effect on the general activity of the vaſcular ſyſtem, and in the vicareous action which takes place betwixt it, the ſtomach and inteſtines, and the kidney and lungs. The ſimilarity of function performed in the lungs and by the ſkin would lead us to attend to the

* Cruickſhanks on Inſenſible Perſpiration.

† Tillet and Fordyce. Philoſ. Tranſ. 1775.

‡ Rollo on Diabetes, Dr. Currie, Abbe Fontana, Dr. Watſon.

injury of the former by the impreſſion of cold on the ſurface and the checked perſpiration. The fact that perſpiration is altered in degree by the progreſs of digeſtion, would lead us to attend to the many occaſions in which we ſee the diſorders of the viſcera affecting changes on the ſkin; the imperfection of the function of perſpiration, when digeſtion and the function of the viſcera are deranged, would lead us not only to mark the ſymptoms of internal diſeaſe on the ſkin but to take the means of exciting the latter as a remedy for the former. In the ſame manner will the ſecretion of the kidney be influenced by the ſtate of the ſkin and of perſpiration: need I add that the health and ſtrength of the circulation, and of courſe the health of all the functions, is influenced by the excitement of the ſkin. Some practitioners take the ſtomach, and others the bowels, and others the liver, on which they harp continually; let any one take the ſkin as his object of care, and his practice will have equal ſucceſs, his caſes and facts become ſoon as numerous, while his connection with general ſcience will be more intimate; and if he introduce his ſyſtem by ſhewing that health is enjoyed when the various functions, which together form the animal œconomy, are perfect, and that one function cannot be in health without the whole be alſo, he will in my opinion have better claims to publick favour than any who have yet flouriſhed in it by promulgating doctrines in regard to the functions and diſeaſes of individual parts.

EXPLANATION

OF

THE PLATES.

PLATE V.

Fig. I.

The eye with the cornea cut away, and the ſclerotic coat diſſected back *.

a. The optic nerve.

b. The sclerotic coat diſſected back, ſo as to ſhew the veſſels and nerves of the choroid coat.

cc. The ciliary nerves ſeen piercing the ſclerotic coat, and paſſing forward to be diſtributed to the iris.

d. A ſmall nerve paſſing from the ſame ſource to the ſame deſtination, but appearing to give off no branches.

ee. Two of the venæ vorticosæ.

f. A point of the ſclerotic coat through which the trunk of one of the veins had paſſed.

g. A leſſer venous trunk.

h. The orbiculus ciliaris of Zinn; the ciliary ligaments of others.

* See Zinn, Tab. iv.

i. The

i. The IRIS.

k. The ſtraight fibres of the iris.

l. A circle of fibres or veſſels which divide the iris into the larger circle k, and the leſſer circle m.

m. This points to the leſſer circle of the iris.

n. The fibres of the leſſer circle.

o. The pupil.

FIG. 2.

A diſſection of the coats of the eye, as they appeared when hung in ſpirits.

A. The OPTIC NERVE.

B. The SCLEROTIC COAT folded back.

C. The CHOROID COAT hanging by its attachment to the ſclerotic coat.

D. The veſſels of the RETINA ſeen as they appeared ſuſpended in the fluid; the medullary part of this coat being waſhed away.

EXPLANATION OF PLATE VI.

FIG. I.

The LENS covered with its capſule, and minutely injected in the fœtus calf.

A. The ARTERIA CENTRALIS RETINÆ.

B. The fringe remaining with the margin of the lens from the attachment of the veſſels of the ciliary body.

FIG. 2.

This figure ſhews the attachment of the capſule of the lens to the membrana pupillaris, in the fœtus calf.

A. The

A. The capſule of the lens very minutely injected; the lens has been allowed to eſcape, and the membrane hangs by its attachment to the membrana pupillaris.

B. That part of the capſule which covers the fore part of the lens; in which, not a veſſel is to be ſeen.

C. The MEMBRANA PUPILARIS, very minutely injected.

D. The IRIS, to the circle of which, the membrana pupillaris is ſeen to be attached, and conſequently, to cloſe the pupil.

E. The CILIARY PROCESSES.

FIG. 3.

The CILIARY PROCESSES, the IRIS, and MEMBRANA PUPILLARIS, as they appear in the human fœtus of the ſeventh month.

FIG. 4.

The appearance of a veſſel which took its courſe acroſs the pupil in the full-grown fœtus, indicating, that the membrana pupillaris was ſtill preſent, although it had become pellucid.

FIG. 5.

A ſection of the optic nerve, to ſhow its great degree of vaſcularity.

A. The body of the nerve quite red with injection.

B. The coat of the nerve.

EXPLANATION OF PLATE VII.

FIG. I.

The repreſentation of an eye with a cataract, diſſected.

A. The CORNEA cut from the ſclerotic coat, and hanging by a ſhred.

B. The SCLEROTIC COAT.

C. The IRIS.

D. The OPAQUE LENS or CATARACT; it is ſeen to have formed an adheſion with the iris.

FIG. 2.

This figure repreſents the effect of couching a ſoft cataract. The needle, inſtead of depreſſing the cataract, cut it into three pieces.

AA. The cut edge of the SCLEROTIC COAT.

B. The CHOROID COAT, and CILIARY PROCESSES.

C. The cataract adhering to the ciliary proceſſes in three diſtinct pieces.

FIG. 3.

This figure repreſents the place into which the couching needle muſt be introduced.

A. The PUPIL ſeen through the tranſparent cornea.

B. The IRIS.

C. The NEEDLE, with the handle elevated, ſo as to depreſs the point.

D. The lens and point of the needle in outline: this repreſents the poſition of the lens when depreſſed: to complete the operation it muſt be carried a little back before withdrawing the needle.

FIG. 4.

A ſcheme, ſhewing the bad effect of introducing the needle near the margin of the cornea.

A. The VITREOUS HUMOR.

B. The LENS.

CC. The CILIARY BODY; on the lower part, torn by the needle.

DD. The IRIS.

E. The anterior chamber of the aqueous humor.

FIG. 5.

Shows the ſituation of the cataract when depreſſed.

A. The ANTERIOR CHAMBER of the aqueous humor.

B. The POSTERIOR CHAMBER of the aqueous humor.

C. The iris.

D. The VITREOUS HUMOR occupying the ſeat of the lens.

E. The depreſſed lens or cataract.

EXPLANATION OF PLATE VIII.

Showing ſome varieties in the ſtructure of the ear in the lower animals.

FIG. 1.

The ear of the lobſter.

A. The membrane which covers the projecting mouth of the ſhell contaning the organ of hearing.

B. A tranſparent pulp or veſicle, upon the bottom of which the web of the nerve is expanded.

C. The inſide of the ſhell containing the organ, which is, of courſe, repreſented broken open.

FIG. 2.

This repreſents a little bone which is ſuſpended in contact with the pulp of the nerve, and which is ſeen but imperfectly in the firſt figure.

A. The bone.

B. An elaſtic membranous, or rather, cartilaginous ſubſtance, by which the bone is ſuſpended.

FIG.

FIG. 3.

The head of a haddock, with the bones broken up, to ſhew the brain and ſemicircular canals.

A. The BRAIN.

B. The SEMICIRCULAR CANALS.

FIG. 4.

The organ of hearing taken out and diſplayed.

A. The SACCULUS VESTIBULI.

B. The boney concretion which lies within, and which, by its vibration, encreaſes the impulſe.

C. The AUDITORY NERVE paſſing to be diſtributed on the ſacculus veſtibuli, and the extremities of the ſemicircular canals.

D D D. The three SEMICIRCULAR CANALS.

E. One of the extremities of the ſemicircular canals in which the branch of the nerve is ſeen to be expanded.

F. A leſſer diviſion of the auditory nerve.

FIG. 5.

The head of a frog with the ſkin taken off; and we now ſee the cavity of the tympanum in this animal, over which the common integuments of the head ſpread tenſe, ſo as to anſwer the purpoſe of the membrana tympani.

A. The point of a little elaſtic bone which is attached behind the tenſe integuments, and receives their vibration. Its further connections are ſeen in the next figure.

FIG. 6.

A magnified view of the internal ſtructure of the frog's ear.

A. The firſt bone, which is attached to the ſkin

B. The ſecond bone, which has its inner extremity enlarged

enlarged ſo as to fill up the foramen ovale, which leads into the inner cavity of the ear.

C. The great inner cavity of the ear of this animal, anſwering to the veſtibule of the more perfect ſtructure.

D. A chalky concretion which lies within this cavity.

FIG. 7.

The head of a ſerpent.

A. A bone connected with the lower jaw.

B. A bone which paſſes from the integuments (behind the large bone A) to the opening into the cavity of the ear, and which, of courſe, receives and conveys the vibration of ſound into the cavity which contains the expanded nerve.

FIG. 8.

The HEAD of the LAND TORTOISE.

A. A large ſcale which ſerves the uſe of the membrana tympani.

B. A ſingle bone which is ſeen to paſs through the cavity of the tympanum; it is attached by an elaſtic bruſh of fibres to the ſcale A, and is enlarged to a head upon its inner extremity. This, filling up the foramen of the inner cavity, conveys the vibration.

EXPLANATION OF PLATE IX.

In this plate, the anatomy of the bones of the human ear is explained.

FIG. 1.

We have here the bones which form the chain betwixt

twixt the membrane of the tympanum and the membrane of the foramen ovale.

A. The MALLEUS.

B. The INCUS.

C. The STAPES.

D. The OS ORBICULARE, which forms the articulation betwixt the incus and ſtapes.

FIG. 2.

In this figure, we have a view of the inſide of the temporal bone, the petrous portion being broken away: we ſee the cavity of the tympanum, the membrane of the tympanum, and the chain of bones.

A. The groove for the lodgment of the lateral ſinus.

B. The hole in the ſphenoid bone for the paſſage of the artery of the dura mater.

C. The petrous portion of the temporal bone.

D. The irregular CAVITY of the TYMPANUM laid open by the breaking off of the petrous part of the temporal bone.

E. The MEMBRANE of the TYMPANUM cloſing the bottom of the meatus auditorius externus.

F. The MALLEUS, the long handle of which is ſeen to be attached to the membrane of the tympanum E.

G. The INCUS, united to the great head of the malleus F.

H. The STAPES, which is ſeen to be articulated with the long extremity of the incus through the intervention of the os orbiculare.

FIG. 3.

Shows the diviſion of the temporal bone into the ſquamous and petrous portions.

FIG. 4.

A. The SQUAMOUS PART of the temporal bone.

B. The

B. The CIRCULAR RING, which forms the meatus auditoris externus in the child.

C. The ZIGOMATIC PROCESS.

D. Cells, which afterwards enlarged into thoſe of the maſtoid proceſs.

FIG. 5.

The petrous portion of the bone, with a view of the tympanum.

A. The CAVITY of the TYMPANUM.

B. MASTOID CELLS.

D. The FORAMEN OVALE, into which the ſtapes (ſee fig. 1. C. and fig. 2. H.) is lodged.

E. The more irregular opening of the FORAMEN ROTUNDUM.

FIG. 6.

Repreſents the labyrinth of the human ear, with the ſolid bone which ſurrounds it cut away.

A. The FORAMEN OVALE.

B. The three SEMICIRCULAR CANALS.

D. The COCHLEA.

E. The tube which conducts the portio dura of the ſeventh pair through the temporal bone.

FIG. 7.

Explains the manner in which the lamina ſpiralis divides the cochlea into two ſcalæ, and the opening of the one ſcala into the common cavity of the veſtibule, and the termination of the other in the foramen rotundum.

A. The bone broken, ſo as to ſhow the cavity of the tympanum.

B. The FORAMEN OVALE.

C. Cellular ſtructure of the bone.

D. The FORAMEN ROTUNDUM.

E. One

E. One of the SCALÆ of the cochlea, which is ſeen to terminate in the foramen rotundum.

F. The other ſcala, which is ſeen to communicate with the veſtibule.

EXPLANATION OF PLATE X.

Theſe two figures are taken from the beautiful plates of the Profeſſor Scarpa, and illuſtrate the ſoft parts contained within the oſſeous labyrinth, and the diſtribution of the nerves.

FIG. 1.

There is ſeen the membranous ſemicircular canals, their common belly, and the diſtribution of the acauſtic or auditory nerve.

a. The AMPULLA of the ſuperior membranous ſemicircular canal.

b. The SUPERIOR MEMBRANOUS SEMICIRCULAR CANAL.

c. The AMPULLA of the external membranous canal.

d. The other extremity of the external canal.

e. The AMPULLA of the poſterior membranous ſemicircular canal.

f. The POSTERIOR SEMICIRCULAR CANAL.

g. The common canal of the ſuperior and poſterior canal.

h h. The ſac common to the membranous ſemicircular canals, viz. the ALVEUS COMMUNIS.

i. The body or trunk of the ACUSTIC NERVE.

k. The larger branch of the nerve.

l. A filament of the nerve to the ſacculus veſtibuli.

m. The leſſer branch of the acuſtic nerve.

n. A filament of the cochlea.

o o. Filaments of the larger branch of the acuſtic nerve to the ampullæ of the ſuperior and exterior ſemicircular canals.

p. The expanſion of the nerve on the common alveus.

q q. NERVUS COMMUNICANS FACIEI or PORTIO DURA.

r. The beginning of the ſpiral lamina of the cochlea.

s. The oſſeous canal of the nerve, which forms part of the foramen auditorius internus.

t. The COCHLEA.

FIG. 2.

The diſtribution of the nerve in the cochlea ſeen by a ſection of the internal auditory canal and cochlea.

a. The SUPERIOR OSSEOUS SEMICIRCULAR CANAL.

b. The poſterior oſſeous ſemicircular canal.

c. The external oſſeous ſemicircular canal.

d. The bottom of the great FORAMEN AUDITORIUS INTERNUS.

e. The trunk of the great acuſtic nerve.

f. The ANTERIOR FASCICULUS of the acuſtic nerve.

g. A plexiform twiſting in the anterior faſciculus of the nerve.

h. A gangliform ſwelling of the nerve.

i. The greater branch of the anterior faſciculus.

k. The leſſer branch.

l. A filament of the anterior faſciculus to the hemiſpherical veſicle of the veſtibule.

m. A branch to the beginning of the lamina ſpiralis.

n. The POSTERIOR FASCICULUS of the acuſtic nerve.

o. The filaments about to enter the tractus ſpiralis foraminuloſus.

p. Theſe

p. Theſe nerves ſeen upon the modiolus.

q q. The filaments of the nerve paſſing forward betwixt the two planes of the lamina ſpiralis.

r r. Their termination on the ſoft part of the lamina ſpiralis.

s. The nerves expanded on the ſecond gyrus of the modiolus.

t t. u u. Their further diſtribution on the lamina ſpiralis.

v v. The INFUNDIBULUM.

x y. The laſt turn and termination of the lamina ſpiralis in the infundibulum.

Fig. 1.

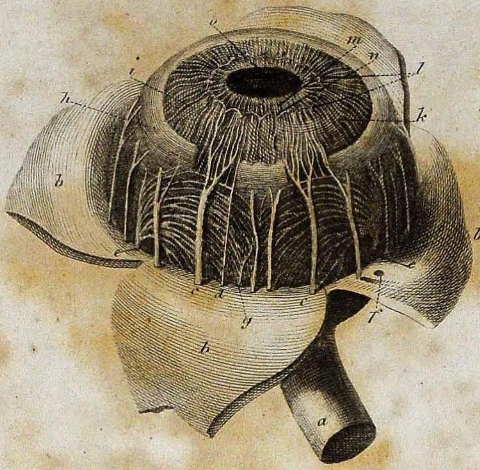

Fig. 2

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Fig 1.

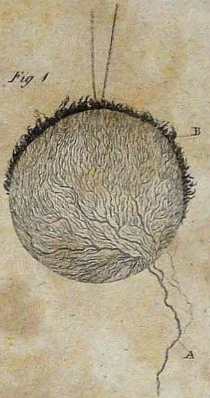
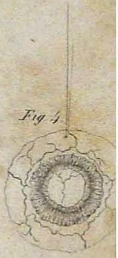


Fig. 3.

Fig 2.

Fig 4.



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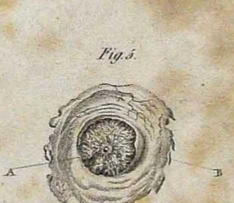

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Fig. 1.

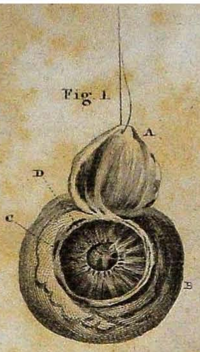


Fig. 2.

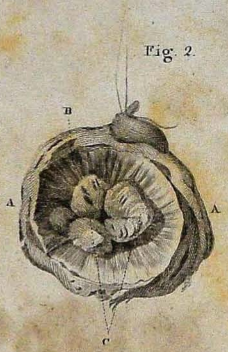


Fig. 3.

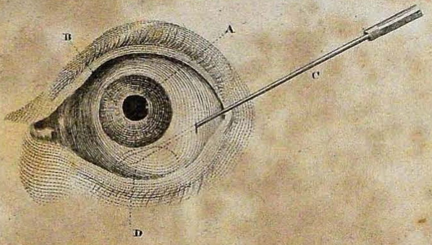
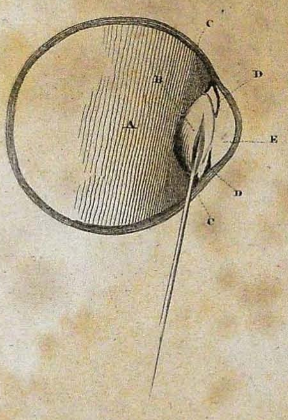


Fig. 4.



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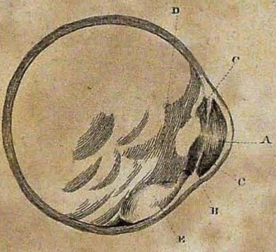

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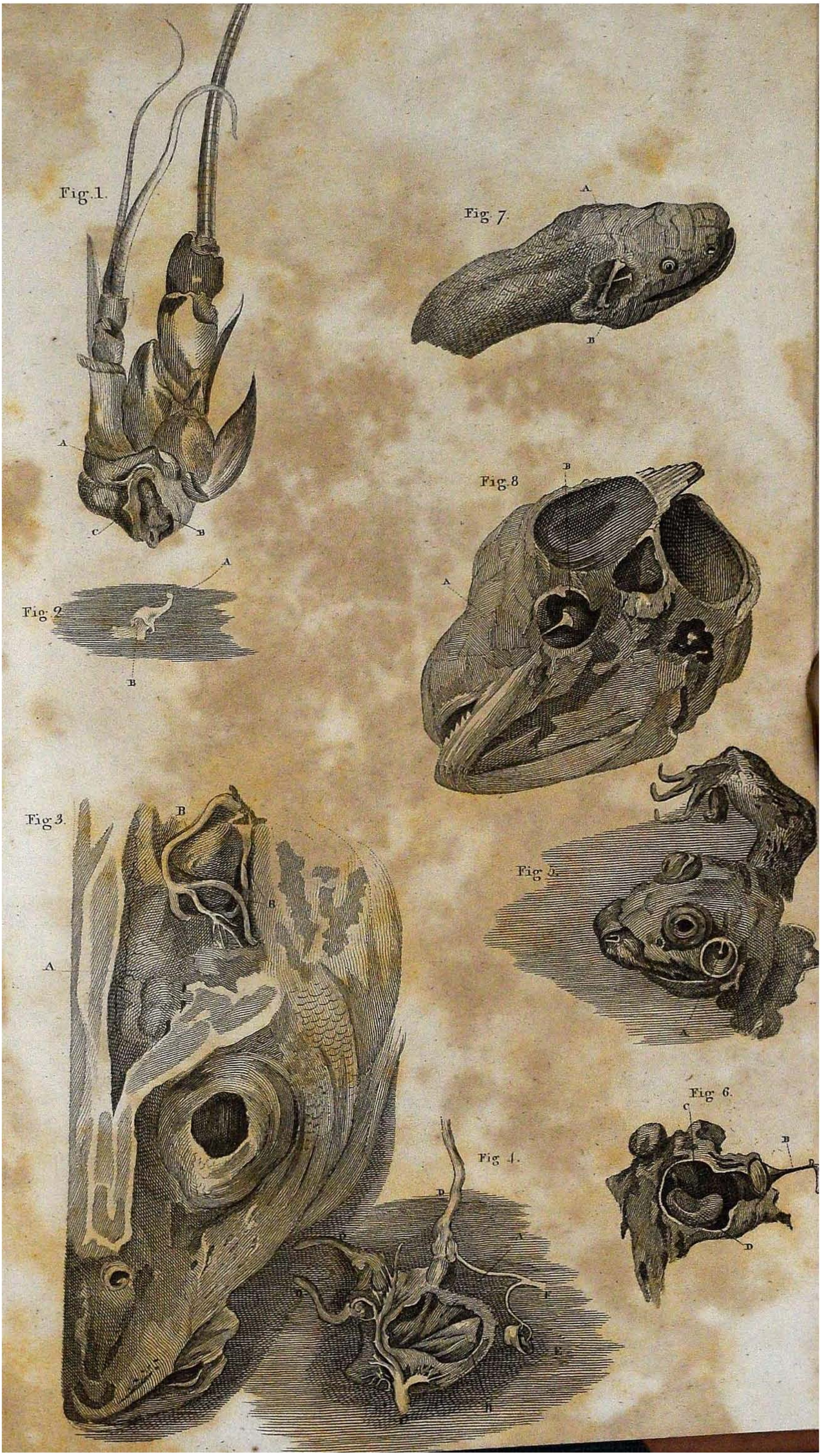
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Fig. 8

Plate IX

Fig. 2.

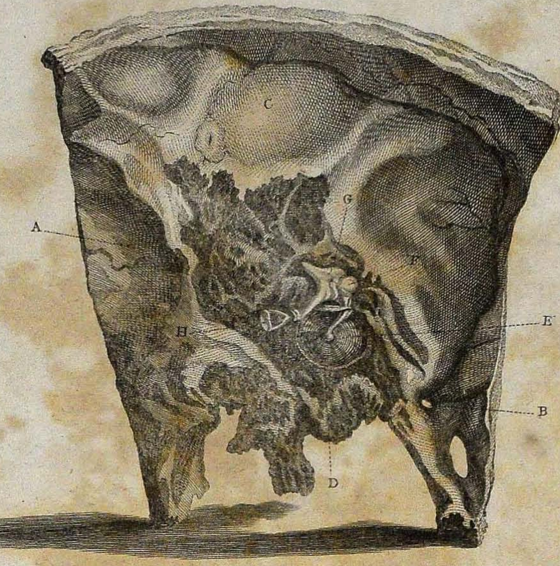


Fig. 1.

Fig. 4.

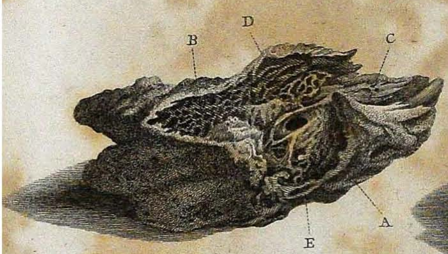


Fig. 3.

Fig. 5.

Fig. 6.

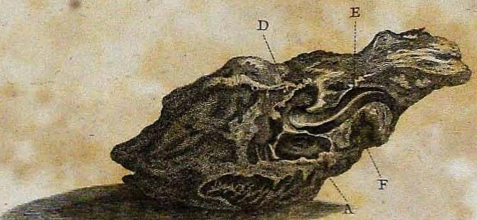


Fig. 1.

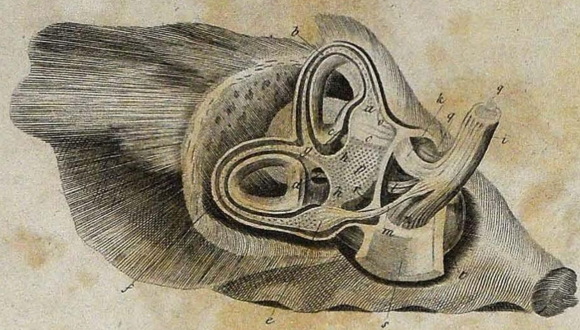
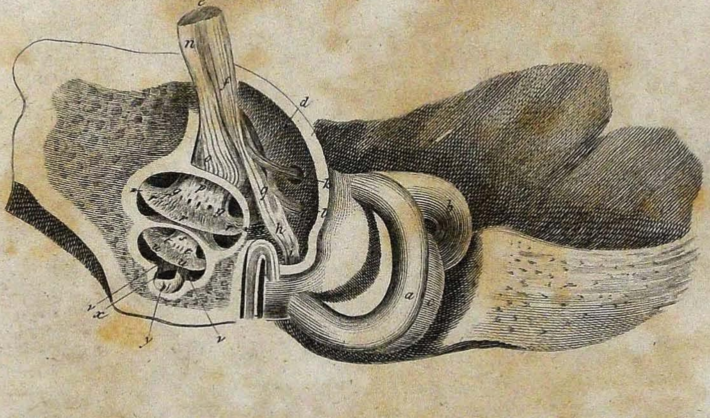


Fig. 2.



D. Lizars sculp.

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THE

ANATOMY

OF THE

VISCERA OF THE ABDOMEN.

THE

ANATOMY

OF THE

VISCERA OF THE ABDOMEN.

INTRODUCTION.

VIEW OF THE SYSTEM OF THE VISCERA, AND OF THE STRUCTURE OF GLANDS.

IN this laſt diviſion of the work we have to comprehend the anatomy and functions of the ſeveral viſcera of the abdomen and pelvis: we muſt conſider them not only as individual parts, but as connected together and as forming with the lymphatic and circulating ſyſtems of veſſels a great part of that chain of mutual dependence and relation which conſtitutes the animal œconomy a whole. It becomes neceſſary therefore, to take here, a general and curſory view of the œconomy of the inteſtinal canal and abſorbing ſyſtem, including at the ſame time ſomething of the hiſtory of opinions regarding ſecretion and the ſtructure of glands. It will be underſtood, that theſe introductory obſervations are meant only to combine the ſeveral parts, and to prevent that manner of deſcription, which is neceſſary to accuracy and minuteneſs, from leading us to conſider the ſeveral parts as diſtinct and inſulated.

An animal body is never for a moment ſtationary: the remoteſt part is in action, and is ſuffering a perpetual change. From the firſt moment of our exiſtence we have commenced a revolution: we, by ſlow degrees, advance

advance in activity and strength, and ripen to maturity; but by as slow and as sure gradations we decline to feebleness and infirmities: and the more rapidly that animals advance in the first stage of their progress, so is their decline proportioned.

But it is not in observing the changes of the animal body from youth to age that the operations of the œconomy appear the most interesting. It is when we find the living body to consist of parts performing a variety of functions, and these connected and mutually dependent; when we see the circulating fluid throwing out fluid and solid secretions to build up and support the body, which is in incessant and daily decay. Again, our admiration is strongly excited when we observe the system to consist of fluids and solids, and the existence of the animal to depend upon the balance of their power; the fluids separating and combining in new affinities, and forming the various secretions; and the solids having action, and that action controlling the affinities and new combinations of the circulating fluids. We find that life subsists by the due action of solids and fluids; or that an incomprehensible influence in a living body is exerted on the latter, and that the chemist can never so combine the fluids out of the body as to imitate the changes produced in a living system of fluids and vessels. Forgetting that animation is the essential character of living bodies, physiologists have too much endeavoured in every age to explain the phenomena of animated nature by illustrations drawn from mechanics, hydraulics, or chemistry.

In a body in which there is life, there is a perpetual waste; first by secretions, which for particular purposes are thrown into the cavities, and afterwards carried out of the body entirely, by the excretions of the kidney, the perspiration by the surface, the exhalation by the lungs, the secretions of the internal cavities as of the intestines. But more than this, there is a decomposition of the solids of the body which are carried into the circulating fluids, and finally dismissed from the system. Lastly, we cannot but observe, that even the powers of muscular motion, nay, the powers of the mind and of the senses, are exhausted by exercise, and renovated

through

through the influence of the circulation. The continued action of a muſcle is followed by feebleneſs, and the continued impreſſion of the rays of light exhauſts the retina, ſo that the object becomes firſt faint and then vaniſhes.

Since there is waſte of the ſolids and fluids, and exhauſtion of the energies of the ſyſtem, ſo alſo muſt there be a ſource of ſupply, and means of renewing its activity. Accordingly, animals have appetites requiring the ſupply of food and the call of hunger and thirſt, which ſtand in relation to the neceſſities of the body. When food is received into the firſt paſſages, there is thrown out from the ſtomach a fluid which diſſolves it, changes its properties, and is itſelf eſſentially altered. The work of aſſimilation is thus begun. As this converted fluid takes its courſe through the inteſtines, it is more and more changed; more aſſimilated to the nature of the peculiar fluids of the animal; and having ſtill additional ſecretions united to it, particularly the bile, it is by theſe means ſeparated from the groſſer parts of the aliment. This fluid, which is now called chyle, is abſorbed by a particular and appropriate ſyſtem of veſſels, which, from their conveying this white and milky-like fluid, are called the lacteals. The lacteal veſſels carry the chyle to the thoracic duct, the trunk of the abſorbing ſyſtem; but not directly; for the chyle is depoſited in the meſenteric glands, from which it is again abſorbed and carried forward. Or if we ſuppoſe theſe glands to be merely convoluted veſſels, its flow is at leaſt delayed, ſo that it is not at once thrown into the maſs of circulating fluids.

We find then that the ſtomach performs digeſtion, and the ſpleen, we will venture to affirm, is ſubſervient to it. The ſecretion of the liver we find to prepare the chyle for abſorption, while at the ſame time it is the peculiar ſtimulus to the inteſtines. The pancreas pours out a fluid which tempers the acrid bile. The ſuperior part of the inteſtinal canal abſorbs the nutritious fluid or chyle, while the groſs remains of the food move on to be depoſited in the great inteſtines. The great inteſtines are not only receptacles, but form at the ſame time an extenſive ſecreting ſurface uſeful in the œconomy, by throwing off the waſte of the ſyſtem.

The lacteal veſſels, which take up the chyle, are but branches of the ſyſtem of abſorbents — which is a ſyſtem conſiſting of two great diviſions, the lacteals and lymphatics: the firſt receiving the nutritious fluids from the inteſtinal canal, and the latter being abſorbents, taking up the fluids which have been thrown out upon the cavities and ſurfaces of the body; and we preſume upon their abſorbing the ſolid parts of the body alſo. Thus the new fluids, rich in ſupplies, are mingled with thoſe which are fraught with the waſte and decompoſition of the ſyſtem. The thoracic duct, the trunk of this ſyſtem, conveys theſe fluids thus mingled together into the right ſide of the heart, where they are received into the vortex of the circulating red blood. Theſe fluids, now agitated and wrought up with the blood in the cavities of the heart, are ſent through the circulation of the lungs, and ſubmitted to the influence of their action and the expoſure to the atmoſpheric air.

When chyle is formed in the ſtomach and inteſtines, it is obſerved to conſiſt of albumen, ſerum, globules, and ſalts: but the change which it may undergo by its reception into the lacteals, its being depoſited in their glands, its mingling with the lymph, its agitation in the heart, have not been obſerved, though it is natural to ſuppoſe that by degrees it aſſimilates in its nature to that of the circulating blood, and does at laſt become perfectly ſimilar by the operation of the lungs.

By the expoſure of the circulating fluids to the atmoſphere in the lungs, the carbon of the blood is thrown off, and the blood, reſuming its purity, is again ſuited to circulate in the body.

That the blood of an animal has properties which diſtinguiſh it from mere matter we readily allow; but to ſay that it poſſeſſes life is to uſe a term in which few will acquieſce. It poſſeſſes properties while circulating in the veſſels diſtinct from thoſe which it ſhews out of the body; and theſe do not depend on the agitation and inceſſant motion, nor on the degree of heat, nor on any ſimilar circumſtance, but apparently on ſome ſecret influence which the veſſels exert over it. The analyſis of the blood by the chemiſts holds out to us little hope of ad-

vancing

vancing in the knowledge of the œconomy of a living animal. Chemiſtry, when applied to the analyſis of animal matter, leaves its devotees in a perplexity of knowledge and diſcoveries which have no end, and which point to no concluſion.

There are produced from the blood a variety of fluids by organs which are called glands, and the formation or ſeparation of theſe fluids is ſecretion. But the ſolid parts of the body ought to be conſidered as ſecretions equally with the matter which flows from the ducts of glands. For there is formed and depoſited from the blood, during the round of its circulation, bone to ſupport the incumbent weight of the body; muſcular fibre, to give it motion; as well as all the other variety of ſolids and fluids. The only difference betwixt theſe ſolid depoſitions from the blood and the glandular ſecretions is, that the former are ſtill within the influence of the vaſcular ſyſtem, and that they are decompoſed and re-abſorbed, conveyed again into the maſs of circulating fluids before they can be finally expelled from the body.

The chemiſts have obſerved the diviſion of animal bodies into ſolids and fluids, but the ſubdiviſions of theſe are very inaccurate. The fluids they have diſtinguiſhed into three claſſes; 1ſt, Recrementitious humors, which go to nouriſh and ſupport the body: 2dly, The excrementitious fluids, which are carried out of the body by certain emunctuaries; and the 3d are of a compound nature, being partly recrementitious and partly excrementitious. We muſt obſerve, however, that the fluids enumerated under theſe heads ſhew it to be a very incorrect arrangement. The *firſt* diviſion comprehends the fat, the marrow, the matter of internal perſpiration, and the oſſeous juice. The *ſecond* comprehends the fluids of inſenſible tranſpiration, the ſweat, mucus, cerumen, urine, fæces. And the *laſt* diviſion comprehends the ſaliva, the tears, the bile, the pancreatic juice, the gaſtric and the inteſtinal juice, the milk, and the ſeminal fluid. To attend to their arrangements of the ſolid parts of animals would be equally remote from ſerving any uſeful end; for they have thrown together parts ſo diſcordant in function and ſo unlike in ſtructure that they can be of no

no uſe in a general view of the œconomy, and cannot in chemical analyſis ſhew a uniform reſult *.

Perhaps all the correctneſs to which we can at preſent pretend is ſome ſuch diviſion as this. Beſides forming the ſolid maſs of the animal body, theſe ſecretions are drawn from the blood: fluids which are ſubſervient to the aſſimilating of new matter to the ſyſtem; fluids which are uſeful in preſerving the mobility of parts; and, laſtly, the ſecretions which convey away the waſte and debris of the body, which is ſucceſſively replaced by the appoſition of new matter.

From this ſhort view of the ſyſtem we underſtand how inceſſantly the powers are ſpent in action, and the fluids exhauſted by depoſition and ſecretion, and how eſſential to life the functions of thoſe parts are which act upon and aſſimilate the food. It is the conſideration of theſe parts which forms the ſubject of the firſt ſection of what remains of the preſent volume. As in the conſideration of theſe functions the ſtructure of the glandular organs becomes a chief ſubject of inquiry, it will be natural at preſent to conſider in a general way the opinions which have been entertained regarding their ſtructure.

The peculiar nature of that organization by which the ſeveral ſecretions are formed, has hitherto eluded abſolute proof by experiment or diſſection. It is imagined that there are ſome organs which do little more than ſeparate the parts of the blood like to the exudation by exhaling arteries. But neither in the exhalent arteries nor in the ſimpler organs can I imagine a ſimple ſtraining of the blood, but rather that the ſame principle influences all, and that the ſeveral varieties of ſecretion depend upon a modification of the action. It would appear that the fluids in circulation and the veſſels containing them muſt reciprocally affect each other: we know that a change on the ſtate of the circulating fluids will alter the nature of the glandular action, and an excitement of the gland will ſtill more powerfully change the nature of the ſecretion; the active power of the ſolids appearing to be an agent which controls and directs the chemical affinities.

* See Fourcroy's Analyſis of Animal Subſtances.

finities. The term gland is applied to certain ſolid and firm bodies, with regular and ſmooth ſurfaces, which are in great number over the whole body. The functions of many of theſe bodies are known. They are found to have ducts which convey from them a ſecreted fluid; but in many of them we diſcover no duct, and can but obſcurely gueſs at their uſe.

We are ſtruck with the variety of form in the ſecreting organs. We ſee a ſimple ſurface pouring out its fluids; or a ſimple canal into which the arteries throw out the ſecretion. We find again the ſecreting veſſels and their ducts convoluted and maſſed together, forming ſuch glandular bodies as I have juſt mentioned; of which kind are the ſolid abdominal viſcera. It is curious to obſerve that in the glandular viſcera there are greater varieties in form than in any of the other parts of the body: in the brain and ſenſes the ſimilarity of the organ of one ſide to the other is correct *; there the organ of one man has a ſtrict reſemblance to that of another; but the glands vary greatly. Thus the kidney is large or ſmall, or ſingle or double, or having three arteries or one; and ſtill it performs its function, and ſecretes in the ſame quantity.

When we diſſect the glands we do not find them to have a ſimilarity in ſtructure. Thus the ſubſtance of the liver, the kidney, the teſticle, &c. are quite unlike, and as their ſecretions are different ſo are their ſympathies: the effect of diſeaſe upon them, and the conſequences of medicine operating through the general circulation will be to attach to one individually, leaving the others in their accuſtomed action. Glands are different not only in their outward form, their general appearance when cut into, and the manner of the connection of their parts, but alſo in a remarkable manner in the length, ſize, and form of their veſſels and ducts.

In conſidering the opinions of phyſiologiſts or anatomiſts regarding glandular ſecretion, and the ſtructure of glands, we find in the firſt inſtance that the old phyſicians contented themſelves with ſaying that the glands or viſcera poſſeſſed a peculiar power to ſelect and ſeparate

* *Anatomie Generale, par Xav. Bichat.*

the

the fluids from the blood. The next clafs had recourfe to hypothefis: they fpoke of the feparation of certain parts by means of fermentation *, or by a kind of filtering through the pores or veffels of glands; that thefe pores allowed only particles of a particular fize or figure to pafs them †. It was oppofed to this hypothefis, that the thinner fluids muft have run through the organs deftined for the groffer fecretions. But when a theory fuch as this is received, no argument nor proof feems neceffary to overthrow it. Refting upon authority alone, it ftood until it was overturned by the fafhion of new doctrines: one equally puerile was raifed upon its overthrow.

We obferve, fays the founder of this theory ‡, that wet or oiled paper will only tranfmit fluid of that kind with which it is previoufly imbued, it will not tranfmit the oil when wetted, nor will the water make any impreffion on the paper when previoufly oiled. Upon thefe facts are to be raifed a theory of fecretion! Betwixt the fecreting veffels and the ducts, in the peculiar tiffue of which glandular ftructure confifts, there is interpofed a fluid of that particular kind which is required to be fecreted, and when the blood is driven againft this tiffue fo imbued, no fluid but of a nature refembling that already depofited can be tranfmitted. By this hypothefis they explained fecretion, making it to depend on the attraction and repulfion of the particles of the blood by fluids previoufly fecreted. We may furely leave this clafs of phyfiologifts accounting for the original depofitation of the fluids in the glands without a wifh to fearch with them into the myftery of glandular fecretion. Commentators on this theory, by taking into the fyftem the action of the nerves, indicated that they did not altogether forget that the body was alive §.

Another fet of phyfiologifts attributed the whole effect of fecretion to the velocity of the blood in the glands or fecreting veffels ‖; others, to the length and curves of

* Van Helmont. Vieuffens, &c.

† Charleton, Defcartes, Borelli, Verheyn, &c. &c.

‡ Winflow. Helvetius.

§ Conor, Tentamen epiftolare de Secretione.

‖ Boerhaave, Pitcarne, &c.

the

the veffels, and their action upon the fluids. Again, others have been fatisfied with the round affertion that the vital action was the effential caufe of fecretion. This, it ought to be underftood, muft be univerfally acquiefced in, while yet there may remain an inquiry as to the apparent ftructure of glands. Difappointed in obtaining an unexceptionable general theory of fecretion, we are only enabled to conclude, that while a power exifts in an animal body, directing its actions, perhaps both in the folids and fluids, and particularly in the mutual influence which they exert, the form, length, and activity of the veffels and ducts give occafion to the greater or lefs degree of intricacy in the operation of the principles upon which the fecretion depends.

Let us then attend to the obfervations of the ftrict anatomifts, and to the appearance which the GLANDULAR VISCERA prefent under the knife.

It is not perfectly clear what the older anatomifts meant by the expreffion Parenchyma. It would appear however to have faved them the trouble of inveftigation, and all abftrufe fpeculation. They meant flefh, yet not mufcular fubftance, but fuch as the liver prefents. This matter they feem to have conceived to be formed by the blood. Thus Higmore defcribes the liver to be formed of the blood of the umbilical vein: the opinion originally of Erafiftratus.

Previous to the time of Malpighi it is fruitlefs to trace the opinions of anatomifts regarding the ftructure of glands. He was the firft who fought to throw light upon this obfcure fubject by anatomical inveftigation, and he made a more rapid progrefs than has been done by any man fince his day. If we take into confideration the difficulties he had to encounter in a new field, and the prejudices of the learned with which he had to combat, his merits will be found greater than even thofe of Ruyfch. The opinions of Malpighi were received by thofe who, forfaking the authorities of names, faw the importance of the ftudy of anatomy. Ruyfch himfelf gave credit to the opinions of Malpighi in the early part of his life. But Ruyfch's more attentive obfervations being contra-

dictory to thoſe of Malpighi, his maturer judgment rejected that anatomiſt's proofs, and with a boldneſs in which he was never remarkably deficient he invented a new theory, or at leaſt alleged new facts, and ſwayed men's opinions with an abſolute authority.

MALPIGHI was an Italian, and born near to Bologna. Whilſt yet a young man, being ſunk under the accumulation of family diſtreſs, abſorbed in grief, and loſt to the conſideration of his intereſt, he received comfort and aſſiſtance from his maſter, who urged him to embrace the medical profeſſion. His progreſs was rapid. After ſtudying at Padua, he was called to fill one of the chairs in Bologna. He was then ſolicited by Ferdinand II., Duke of Tuſcany, to be profeſſor in the univerſity of Piſa. Here he was aſſociated with liberal men; and now only in his ſecond profeſſorſhip did he learn to deſpiſe the ſcholaſtic learning of the time, and betook himſelf to experiment as the only means by which philoſophy could be raiſed from the oppreſſive barbariſm of the ſchools. Malpighi and Borelli were aſſociated; they diſſected together; they ſuggeſted thoughts to each other; they doubted, and canvaſſed freely each other's opinions; and were to each other an excitement and encouragement to perſeverance and induſtry. They were ſupported by government; popular in their teaching; while they collected round them the learned men of the time. This was the origin of the famous Academy del Cimento. Malpighi was, after this, profeſſor in Meſſene, and died in the Quirinal palace at Rome of a ſtroke of the apoplexy *, after having been ſome time phyſician to Pope Innocent XII. Malpighi had many enemies, and even ſome of his colleagues were animated againſt him with a diſhonourable jealouſy. Many laughed at his ſtudies and occupations as frivolous and abſurd. Something muſt be allowed for men who had laboured with diligence to become learned; for theſe, his opponents, had paſſed their lives in the ſtudy of the Arabian writers. With them ſtudies were enforced which held ſcience in ſubjection; ſtudies which, in place of invigorating, ſerved only

* Much coagulated blood was found in the ventricles of his brain by Baglivi.

to

to chill and paralyſe exertion, and retard ingenious inveſtigation. Even Borelli, but from other motives, oppoſed and cenſured ſome of the diſſertations of Malpighi.

Malpighi has been conſidered as the inventor of this department of anatomy, which the French, curious in diſtinctions, have called the analytic method. He ſhewed the impropriety of the term Parenchyma, as applied to the ſubſtance of glands. He proved that the lungs, for example, (which they alſo called Parenchymatous,) were not fleſhy, and had no reſemblance to the glandular viſcera of the abdomen. He taught, that though glands are ſmooth on their outer ſurface, they conſiſt of lobules connected by cellular membrane: and, upon a ſtill more minute inveſtigation, that they conſiſt of innumerable little folicules or ſacs; that theſe are interpoſed betwixt the arteries which convey the fluids and the excretory ducts going out from them; that the arteries, or the vaſa afferentia, after ramifying and encircling theſe bodies, pierce them and ſecrete the fluids into them. On other occaſions he deſcribes theſe little glandular bodies as appended to the ramifications of the arteries, like fruit hanging by the branches of a tree.

Malpighi threw in his liquid injections; diſſected and examined with the microſcope; made careful obſervations and experiments on living animals; and laſtly, attended in a particular manner to the phenomena of diſeaſe. By diſeaſe no doubt parts ſwell out and are magnified, and become diſtinct; but it is not a teſt of the natural ſtructure, or implicitly to be truſted to.

Scheme of Malphighi's opinion.

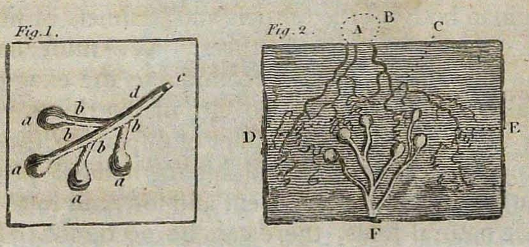

Fig. 1.

Fig. 1. Boerhaave's plan of Malpighi's doctrine. *a a a* folliculos glandularum ſimpliciſſimarum denotat. *b b b* ſingularia emiſſaria cuique utriculo *a*, propria atque in communem canalem excretorium *d*, *c*, ſuos humores demittentia qui tandem per hujus aperturam *c*, emittantur.

Fig. 2. is a ſcheme farther to elucidate the opinions of Malpighi. A, an artery entering a portion of a viſcus. B, the returning veins. C, the branch of communication betwixt the artery and vein which ſerves to circulate the blood, and convey a part into the veins. D, another diviſion of the artery, which after various playful meanderings, terminates in the folicule or little glandular bag E. F, the ducts which receive the ſecreted fluid from the folicules.

Ruysch ſtudied at Leyden under Van Horne, and at a very early age attached himſelf to anatomy and botany. At this time he brought himſelf into notice by a defence of the profeſſors againſt one Bilſius, who, although he was learned and acute, had attacked them with all the weapons of a Charlatan. Returning to his native country, he was raiſed to the profeſſorſhip of anatomy and botany in Amſterdam. It was here that Ruyſch made thoſe diſcoveries in anatomy, and that wonderful and ſudden progreſs in practical anatomy, which not only raiſed him above his cotemporaries, but has been the admiration of all ſince his time. Though new and various methods of preparing the body have been diſcovered ſince the time of Ruyſch, yet there has been no approach to the elegance with which he diſplayed the ſtructure of minute parts. It has been ſaid that, while others preſerved the horrid features of death, Ruyſch preſerved the human body in the ſoftneſs and freſhneſs of life, even to the expreſſion of the features. We muſt no doubt aſcribe ſome part of this encomium to the exaggeration naturally ariſing from the novelty of the thing. But as to his ſuperiority in the manner of diſplaying the minute veſſels of delicate parts, and his methods of preſerving the parts in liquors, tranſparent and ſoft, and ſo as to float in their natural folds, there can be no doubt. Neither can

can the minutenefs and fuccefs of his injections be denied: we have too many occafions in which we muft refort to the catalogue of Ruyfch's mufeum for the true anatomy, to doubt his great fuccefs, or to queftion the truth of thofe encomiums which have been beftowed upon him.

Kings, princes, ambaffadors, and great generals, but more than thefe, all the learned men of the time, crowded to the mufeum of Ruyfch. We muft not blame him if, whilft others were merely fpeculating about the ftructure of parts, he, furrounded by fo princely a mufeum, fhould fimply have laid open his cabinets, and bid them fatisfy themfelves whether or not he was right. Ruyfch's preparations went to contradict the opinions of Malpighi. His injections, pufhed more minutely, fhowed thofe round bodies which are to be feen in fome of the glandular vifcera (and which Malpighi took to be little bags into which the fecreted fluid was poured) to be merely convoluted arteries. Ruyfch taught, that the minute arteries after making thefe convolutions terminated in the beginning of excretory ducts; that there was no fubftance or apparatus interpofed, but that the veffels and ducts were continuous. His opinions being formed upon the ftrength of more minute preparations, and a fuperior dexterity of anatomical inveftigation, few anatomifts chofe to be outdone, or to acknowledge that they could not fee what he faw. This I believe to be one reafon of the rapid progrefs of Ruyfch's opinion.

Scheme of Ruysches opinion.

1 1 The fmaller arteries which do not enter into folicules, but are convoluted. 2 2 The appearance of bodies

bodies or bags, but which are merely owing to the convolutions and tortuous figure of the arteries before they terminate in the excretory ducts. 3 3 Excretory ducts or veſſels formed by the continued extreme branches of the arteries *.

The opinions of Malpighi and Ruyſch have held the ſchools in perpetual controverſy; moſt anatomiſts however leaning to the authority of Ruyſch. There follows theſe a crowd of French academicians, who, with Boerhaave, may be conſidered as mere commentators on the original authorities of Malpighi and Ruyſch. Some of theſe argue for ſecretion by continuous veſſels, and contend that the arteries terminate in the excretory ducts; others, that the ſecretions are made into folicules; and ſome, as Boerhaave, inſiſt that both are right in their obſervations, and in the proofs which they have adduced, that ſecretion is in part performed by continuous veſſels, partly by a more intricate glandular apparatus.

I am ſure that I wiſh to ſpeak with high reſpect of Bichat, yet I cannot help ſaying that it is edifying in a way which he did not intend it to find him thus expreſſing himſelf. Authors have occupied themſelves a great deal about the intimate ſtructure of glands. Malpighi admits that they are ſmall bodies of a peculiar nature, and Ruyſch has eſtabliſhed it that they are entirely vaſcular. Let us neglect theſe idle queſtions, where neither the eye nor experiment can be our guide; let us begin

* Ruyſch's doctrine again was thus oppoſed: "Ruyſchius auget "arte ſua replendi extenſionem vaſorum ultra naturalem magnitu-"dinem. Ruyſchius arte ſua deſtruit glandulas; dein negat. Ruyſ-"chius negat omnes glandulas. Melius eſt & tutius omnia hæc de-"monſtrare in cadavere recenti." F. Ruyſch Epiſt. ad Vir. Clar. Her. Boerhaave, p. 50.

It may be further obſerved, that it was not in the mere fact of there being folicules, in which Malpighi and Ruyſch differed; for the latter conceded that there were hollow membranes, but contended that theſe were not glands. Their difference of opinion is expreſſed in the following words of Ruyſch: "Adeoque diſcrepantia inter magnum illum virum et inter me eſt, quòd ille putat humores delabi in glandulas dictas ſimpliciſſimas,—ibi foveri, mutari: Ego puto, quòd arteriæ ultimæ ſuccos faciant, & factos ibi deponant."

to ſtudy anatomy where the ſtructure of organs come under the ſenſes. The rigorous advance of ſcience in this age does not yield to theſe frivolous hypotheſes; and ſo forth. He does not then retrace the ſteps of the mechanical philoſophy, nor enter into the ſcience of hydraulics, nor attach himſelf to the newer ſchool of chemical phyſiologiſts, but in truth gives origin to a new ſchool, *de l'art du cuiſinier*. He cooks it; he boils the liver and the kidney, &c. he drys them, boils them again; obſerves with all poſſible minuteneſs and gravity what floats in ſcum, what remains behind, what gets ſoft, what hardens by boiling; he ſmells and taſtes; or he roaſts the glands with the ſame ceremony, and ſtill imagines the while he is deeply philoſophical.

Of the ſecretions diſcharged from the glands it may be ſufficient to ſay, that many of them are deſtined to be uſeful to the further operations of the œconomy; that they are all liable to be abſorbed upon any obſtruction to their evacuation; and that as far as experiments on brutes go, all the animal ſecretions may be even injected into the circulating fluids without greatly diſordering the ſyſtem *.

The blood carried into the glands has nothing peculiar in its appearance and ſenſible qualities: the idea once entertained, that the blood iſſuing from the heart immediately commences a ſeparation of its parts for the ſeveral ſecretions, is quite unſuſtained; and if it deſerves a ſerious refutation, we have it in the varieties to be obſerved in the diſtribution of the arteries to the glands; for a different origin of a ſecreting artery would in that ſuppoſition change the ſecretion †.

In ſome of the glands the arteries and veins have a peculiar appearance; they are convoluted, and reflected

* Haller, by experiments, proved that ſeveral kinds of foreign matter may be conveyed into the circulating blood; and Bichat has made the experiment of injecting all the animal ſecretions into the veins of brutes.

† *Bichat* has alſo taken the trouble of examining the blood of the carotid artery, and of the ſpermatic artery, without being able to obſerve any difference.

ſo curiouſly, as to have given riſe to the idea of their preparing the blood for the ſecretion: thus in the ſpermatic cord the veſſels have been called the *vaſa preparantia*. But this convolution of veſſels is for another purpoſe.

Nothing peculiar has been obſerved in the diſtribution of nerves to the glands. They are comparatively ſmall. They have been cut, and ſtill the ſecretion has gone on. As however moſt of the higher and diſtinguiſhing properties of life reſide in the nervous ſyſtem, ſo it is reaſonable to ſuppoſe that not only the various ſympathies and ſenſibilities which the glands poſſeſs are derived from the nerves, but alſo that the ſecretions which they ſeparate from the general maſs of blood, is owing to an influence of life reſiding in their nerves.

This capacity of the life of glands, more than any thing in their ſituation, form of the gland itſelf, or number of its veſſels, eſtabliſhes a certain relation with the parts of the blood tranſmitted through it. This muſt be the reaſon that bile is not ſecreted but in the liver; that urine never paſſes off by any other gland than the kidney; and ſo forth. Moſt probably, too, as medicines are differently ſoluble in the conſtituent parts of the blood, this may be a reaſon why particular medicines attach excluſively to particular glands, as mercury affects the ſalivary glands, and certain aliments produce more milk, &c.

As the forms of the parts which throw out ſecretions have an infinite variety, it may be uſeful in this introductory view to point out theſe varieties, and their appropriate names*. In the firſt place, although in general language the term gland implies a ſecreting body, yet this does not follow from the definition of that word. According to Hippocrates, it is a tumid round body, ſoft, ſmooth, and ſhining. Many ſuch bodies, and which we call glands, have no excretory ducts, and do not ſecrete a fluid; while moſt ſecreting parts admit of no ſuch

* The terms acini, cotulæ, cryptæ, foliculi, glandulæ, lacunæ, loculi, utriculi, have been almoſt promiſcuouſly uſed; being ſo many names for bundles, bags, bottles, holes, and partitions.

definition.

definition. When, again, we admit the definition of authors who have taught their peculiar opinions regarding their ſtructure, we have a ſtill leſs admiſſible deſcription. Thus Malpighi defined a ſimple gland to be "Membrana cava cum emiſſario;" and Ruyſch ſays, "Glandulæ non nullæ componuntur ex ſola membrana cava cum emiſſario ſed præcipue ex vaſis."

Theſe definitions of glands being optional and uncertain, it is neceſſary to uſe names appropriated to the ſeveral varieties of form in ſecreting parts. Indeed the term gland is inadmiſſible as conveying any knowledge of the minute parts of which the viſcera are compoſed.

We muſt obſerve, however, that there is a diviſion of glands ſtill in uſe into *conglobate* and *conglomerate*. The firſt implies a gland ſimple in its form, the latter a gland having the appearance of an aſſemblage of ſeveral glands *. Now there is no gland that has not more or leſs the appearance which is deſcribed by conglomerated; that is, conſiſting of ſeveral parts, united by cellular membrane: and the diſtinction is attended with no advantage.

Acini form the laſt ſubdiviſion which we obſerve in the viſcera, as in the liver; they are round bodies, not regularly inveſted with membranes, and which can be teaſed out into parcels of minute veſſels †.

Cryptæ are numerous in the body. We have an example of them in the great inteſtines ‡. Crypta is a ſoft body, conſiſting of veſſels not completely ſurrounded with a membrane, and reſolvable by boiling or maceration §.

* As the ſalivary glands and the pancreas. Farther, the lymphatic glands are generally called conglobate glands, being ſmooth and apparently ſimple in their ſtructure; but theſe, when injected, take exactly the appearance which ſhould naturally be deſcribed by the term conglomerate, conſiſting of many little cavities. Theſe lymphatic glands, belonging to a diſtinct ſyſtem, require no farther particular definition to diſtinguiſh them.

† See farther of the acini of the liver for example.

‡ Ruyſch ad Virum Clar. H. Boerhaave, p. 53.

§ "Cryptarum vaſcula poſſum docere, ſed ſunt tam ſubtilia, ut reptatus non poſſit diſtingui; tantum circum affuſa rubedo per repletionem videtur." Ruyſch ad Her. Boerhaave, p. 77.

Folicules are little bags appended to the extremity of the ducts, into which the fecretion is made, and from which it is evacuated by the ducts.

Lacunæ are little facs opening largely into the paffages, (as in the urethra,) and into which generally mucus is fecreted; which, lodging there, is difcharged when matter moves along the paffage.

Finally, we have to recollect that every part of the body fecretes; that every furface is a fecreting furface; that even that furface which is produced by an incifion no fooner ceafes to bleed than a fecretion begins. And that an ulcer in the fkin or flefh becomes by habit fimilar to thofe organs the peculiar functions of which is to fecrete fome matter ufeful in the fyftem. This fact corrects the notions which we fhould otherwife be apt to receive of the action of fecretion from contemplating the more complicated glandular organs.

CHAP. I.

OF THE ABDOMEN IN GENERAL, AND OF THE PERITONEUM.

THE abdomen is that divifion of the body which is betwixt the thorax and pelvis. It is bounded above by the arch of the diaphragm; behind, by the fpine; on the fides and fore part by the abdominal mufcles; and below, the abdominal vifcera are fupported by the alæ ilii and the pubis. The abdomen contains the vifcera more or lefs immediately connected with digeftion, and the kidneys which fecrete the urine.

We fpeak of the cavity of the abdomen; but it is an inaccuracy of language; for there is really no cavity. The parietes of the abdomen, viz. the abdominal mufcles and peritoneum, clofely embrace the contained vifcera. To underftand what is meant by the cavity of the

the abdomen; to underſtand the connection of the ſeveral viſcera, and the manner in which they lie contiguous, while they adhere at certain points only; we muſt attend to the peritoneum. But, in the firſt place, let us notice the outward diviſions of the belly.

OF THE REGIONS OF THE BELLY.

To give greater accuracy to the deſcription of the ſeat of the viſcera, or, perhaps rather, more ſtrictly to connect the knowledge of the internal parts with the outward marks of the belly, it has been long cuſtomary to mark certain arbitrary diviſions on its ſurface, which are called regions.

The EPIGASTRIC REGION is the upper part of the belly, under the point of the ſternum, and in the angle made by the meeting of the cartilages of the ribs with the ſternum. Upon the ſides under the cartilages of the ribs are the HYPOCHONDRIAC REGIONS, or the right and left hypochondrium. Theſe three regions make the upper diviſion of the abdomen, in which are ſeated the ſtomach, liver, ſpleen, pancreas, duodenum, and part of the arch of the colon. The ſpace ſurrounding the umbilicus, betwixt the epigaſtrium and a line drawn from the creſt of one os ilii to the other, is the UMBILICAL REGION. The HYPOGASTRIC REGION is of courſe the loweſt part of the belly, conſiſting of the angle betwixt the umbilical region, the ſpines of the oſſa ilii and the pubis. The two lateral ſpaces betwixt the falſe ribs and the ſpine of the os ilii are the ILIAC REGIONS, or the LOINS.

OF THE PERITONEUM.

The peritoneum, like all the other membranes of the body, conſiſts of an expanſion of denſe cellular membrane; yet it is what is called a proper or ſimple membrane; being a white firm thin contexture of cellular ſubſtance, in which no fibre or ſtriated appearance is to be

be obſerved *. By its outer ſurface it adheres to the adipoſe membrane, on the inſide of the abdominal muſcles, and to the ſurface of the ſeveral viſcera; its inner ſurface is ſmooth, and forms no adheſion while the parts are ſound and healthy; its outer ſurface is looſer in its texture, and by the ſplitting of its lamina, it degenerates into the common cellular membrane.

The cellular membrane on the outſide of the peritoneum is in ſome places ſhort, firm, and denſe; as on the liver, the ſpleen, the uterus, and the inteſtines: but it is longer, lax, and fatty, where it attaches the peritoneum to the muſcles and tendons of the abdomen.

The peritoneum has no termination; or it is a ſac; yet ſo curiouſly is it involved with the viſcera, that though we ſay the viſcera are contained in the abdomen, yet, accurately ſpeaking, they are without the peritoneum, and conſequently lie not in the abdominal cavity †.

The peritoneum is expanded on the lower ſurface of the diaphragm; and at ſome of the interſtices or perforations of that muſcle or its tendon it comes in contact with the pleura, and adheres to it by cellular ſubſtance. From the diaphragm the peritoneum is reflected off to the liver, forming the ligaments of that viſcus, and, expanded over its ſurface, it forms its outer membrane. From the diaphragm it is alſo ſent off upon the œſophagus and ſtomach, and prolonged to the ſpleen on the left ſide (as it is to the liver on the right) ſo as to form the ligaments of the ſpleen.

The aorta, the great vena cava, the thoracic duct, and the kidneys, are behind the peritoneum; that membrane being ſtretched before them. But the inteſtines are alſo in the ſame reſpect behind this general inveſting membrane; for it is merely reflected from the ſpine and pſoas muſcles, and from the great veſſels running down

* The meaning of ſome anatomiſts, ſaying, that the peritoneum is a double membrane, will be ſeen below.

† See Plate I. and the explanation. Appertis corporis cavitatibus viſcera recte nuda dicuntur, licet continuata cavitatis membrana obducta. *Bonn. de continuatione membranarum. Sandifort.*

upon

upon the ſpine, ſo as to involve the inteſtines and form their outer coat. As it ſtretches towards the tract of the inteſtinal canal, it conſequently involves the veſſels of the inteſtines in its duplicature, and forms the meſentery.

The peritoneum alſo lines the abdominal muſcles; it is reflected from the diaphragm upon the ſurface of the tranſverſalis and rectus abdominis muſcles. Here it is united to them by a looſe adipoſe membrane, and from the abdominal muſcles it is continued upon the inſide of the pubes. From the pubes it aſcends upon the bladder of urine; deſcends again behind the bladder; and there, making another reflection to mount over the rectum and form the meſo-rectum, it leaves betwixt the rectum and bladder a particular ſacculus.

From this detailed deſcription we ſee that the peritoneum has no termination; that it is continued from the ſurface of the diaphragm to that of the abdominal muſcles; from that over the bladder and rectum; from the rectum in the whole length of the inteſtinal canal; and from the inteſtinal canal up upon the diaphragm. We ſee then what is meant when it is ſaid that it is a ſhut ſac; we underſtand by the cavity of the peritoneum merely the inſide of this ſac; and that when diſtended with fluid, that fluid is contained betwixt the peritoneum lining the abdominal muſcles, and that part of it which inveſts or forms the outer membrane or coat of the inteſtines. This fluid, whether collected there by diſeaſe or thrown in by experiments, has no natural outlet, nor does it tranſude in the living body*.

* Soemmerring, Corp. Hum. Fab. Contemp. Peritonei, § iii.
We not unfrequently find an accurate general deſcription in authors, but ſome incorrectneſs in the ſubordinate detail; which throws back the ideas of the reader into confuſion. Such is the enumeration of the holes or perforations of the peritoneum, "pour donner paſſage à l'œſophage, à la veine-cave," &c. See Anatom. Chirurg. par M. Palſin. We ſee that there are no ſuch perforations, that the œſophagus never enters into the cavity of the peritoneum, nor does the rectum paſs out from its cavity. This was indeed explained by Fernelius in oppoſition to Galen. See a deſcription of the inflections of the peritoneum by Bartholin.—Specimen Hiſtoriæ Anatomicæ Analect. Ob. I.

BLOOD-VESSELS OF THE PERITONEUM.

As the peritoneum is a membrane of great extent, and investing a variety of parts, its vessels come from many sources. It receives arteries and veins from the mammary vessels; from the phrenic and epigastric vessels; from the lumbar arteries and veins; and from the ilio-lumbalis, circumflexa ilii, renal, and spermatic arteries. It receives nerves from the intercostal, lumbar, and diaphragmatic nerves.

It would appear that disease has given rise to the opinion that the peritoneum has in it many little glands. This is controverted decisively by Morgagni.

OF THE USE OF THE PERITONEUM.

The peritoneum serves as a dense and outer coat to the abdominal viscera; conveys the vessels to them, as in the example of the mesentery; and, having its inner surface smooth and lubricated by a watery secretion, it allows the parts to lie in contact (they being strongly compressed by the surrounding abdominal muscles and diaphragm), and at the same time allows in the intestinal canal a capacity of motion without friction.

There is no internal surface or cavity, as it is called, of the living body, which is not moistened by an exudation from the vessels of the surface. Thus it is with the peritoneum. An exhalation from the extreme arteries bedews its surface, and is again taken up by absorbent vessels; so that it does not accumulate in health, nay even fluids poured into the abdominal cavity will be taken up by the absorbents*. When the abdomen is opened in

* See Nuck Sialograph. c. ii. p. 27.

Qua copia in statu secundùm naturam secernatur dictu difficile est: ad uncias certe collecta aquula in sani hominis abdomine reperitur. (Kaawn, 543.) In homine, cui sponte abdomen sub umbilico ruptum erat ad quinque & sex libras de die effluebat. (Journ. de Med. 1757. M. Aug. ut denique 800 libr. effluxerent.) This, however, proves nothing of the nature or quantity of the secretion; this has probably been an inflammation and abscess of the peritoneum, which, we have seen, pours out such a quantity of fluid, thin and serous, as quickly to drop through the bed-clothes upon the floor.

in animals alive, or recently killed, as in the ſhambles, a vapour is ſeen to exhale from the peritoneum having a peculiar animal odour. Yet we ought not to ſay that this vapour is collected in the dead body; for before the opening of the peritoneum, or the death of the animal, it is not in a ſtate of vapour, but is condenſed into a watery exudation*. I have ſeen, in the high ſtate of inflammation of this membrane, pus formed upon the ſurface without ulceration, and therefore, probably, from the ſame exhaling or ſecreting ſurface; and coagulable lymph lying in flakes upon it. The increaſe of the ſerous diſcharge forms the common aſcites; but whenever the natural ſecretion or exudation from the peritoneum is altered, adheſions are apt to form.

One great uſe of the peritoneum is to retain the viſcera in their place, ſays Haller; for when it is wounded they eſcape, and ſometimes with a ſudden impetus, which makes it difficult to reduce or retain them †. But this is not from the want of the embracing of the peritoneum, but from the tendons or muſcles which ſupport the peritoneum being cut; for when there is a deficiency in the ſupport given by the abdominal muſcles, or their expanded tendons, the peritoneum does not prevent the viſcera from being protruded, but eaſily yields to their forcible protruſion, and forms a ſac involving this hernia.

Nor do the proceſſes of the peritoneum, which have received the name of ligaments, nor the meſentery, nor meſocolon, ſufficiently reſiſt the prolapſus of the viſcera when they have eſcaped from the preſſure of the ſurrounding muſcles. Sufficient example of this we have in hernia of the inteſtines, in which the meſentery is greatly elongated, or in the diſplacement of the ſtomach, or in the prolapſus and procedentia uteri.

The peritoneum which forms the ſac of hernia retains little elaſticity, and does not ſhrink into the belly when

* This vapour I have ſeen ariſing from the inteſtines of the human body during the operation for hernia; and alſo when the omentum and inteſtines have eſcaped in conſequence of a wound of the belly.

† Element. Phyſiol. tom. ii. p. 380.

freed

freed from the outer adhefions; but the general peritoneum will allow great diftention, as in afcites, and quickly contract to its former dimenfions on the evacuation of the fluid; and fo that part of the membrane which invefts the ftomach and inteftines the bladder of urine and gall bladder, has confiderable elafticity, fince it fuffers thefe parts to be diftended and again returns to its former dimenfions.

The confideration of the infufficiency of the peritoneum to retain the vifcera leads us to attend to a circumftance of the greateft importance connected with the vifcera of the belly. The abdomen is every where (except towards the fpine) furrounded by mufcles. Above we fee the diaphragm; before, and to the fides, the abdominal mufcles; and even below, the parts in the pelvis are furrounded and compreffed by the levator ani, in fuch a manner that the whole of the vifcera fuffer a continual preffure. This preffure upon the vifcera appears to be uniform and conftant, notwithftanding the alternate action of the abdominal mufcles and diaphragm as mufcles of refpiration: but it muft be occafionally very violent during exertions; in pulling, for example, or in ftraining, as a failor muft do in working of the great guns, or when pulling at the oar, or when balancing himfelf upon his belly over the yard-arm. And indeed by fuch violent and general compreffion of the vifcera of the belly, ruptures are fometimes produced, of the worft kind, and followed by an immediate train of urgent fymptoms.

The vifcera having in general delicate outer coats, and no ligaments capable of fupporting them, and being very vafcular, require the fupport of this preffure of the furrounding mufcles; and the great venous trunks which take their courfe through the abdomen are in a particular manner indebted to the preffure of the abdominal parietes. We muft recollect alfo the bad confequences which refult from the fudden relaxation of the abdomen; as in women after delivery, or in confequence of withdrawing the waters of afcites without due compreffion of the

the belly; languor, faintnefs, and even death, are fometimes produced, apparently by the balance of the vafcular fyftem being deftroyed.

Some good authors in former times have defcribed the peritoneum as a double membrane*. This was no farther a miftake than as they confidered the cellular membrane, which lies without the peritoneum, as a part of it. It is neceffary to recollect this in order to underftand the meaning of their calling the fheath of the cellular membrane, which accompanies the veffels paffing out from the abdomen, productions of the peritoneum. The vaginal productions of the peritoneum are the fheaths of the common cellular fubftance which accompany the aorta and œfophagus into the pofterior mediaftinum; or which give a bed to the fpermatic veffels, or paffing under Poupart's ligament accompany the veffels of the thigh. They are improperly termed productions of the peritoneum.

The proper productions or prolongations of the peritoneum are of a very different kind; they are the mefentery and omenta and ligaments: but, as I have explained in general how the mefentery and ligaments are formed by the peritoneum, and as they muft come prefently to be confidered more particularly, we treat no farther of them here†.

OF THE OMENTA.

The Omenta are confidered as fecondary proceffes of the peritoneum, becaufe they are not formed by the peritoneum reflected off from the fpine upon the inteftines, as the mefentery is,—it being a primary procefs; but they are reflected from the furface of the ftomach and inteftines. Anatomifts diftinguifh the omentum majus,—colico-gaftricum: the omentum minus,—hepatico-gaftricum; omentum colicum; and laftly, the appendices epiploïcæ.

* See Anat. Chirurg. par M. Palfin, tom. II. p. 35. and note *a*.

† See farther of the peritoneum under the head Mefentery, Mefocolon, Defcent of the Tefticle, &c.

The

The OMENTUM, or EPIPLŌON, meaning thereby the great omentum, is a floating membrane of extreme delicacy, expanded over the ſurface of the ſmall inteſtines, and attached to the great arch of the ſtomach and inteſtinum colon. Although this membrane be of extreme delicacy and tranſparency in the young ſubject*, yet it is much loaded with fat, and appears tranſparent in the interſtices only; and in advanced age it loſes much of its delicacy, and acquires a degree of diſeaſed conſolidation or firmneſs, and is often irregularly collected into maſſes, or adheres preternaturally to ſome of the viſcera.

The omentum majus hangs ſuſpended from the cellular connection betwixt the arch of the ſtomach and the great tranſverſe arch of the colon; or rather it forms that connection betwixt the ſtomach and colon. It conſiſts of two membranes, or is as a ſac collapſed and hanging from the ſtomach and colon †, one of the ſides being the peritoneum reflected off from the œſophagus and alongſt all the great arch of the ſtomach, and the other that which comes from the arch of the colon. And further, as each of theſe lamina may be ſuppoſed to conſiſt of two lamina; for example, where the omentum is formed by the meeting of the peritoneum from the lower and upper ſurfaces of the ſtomach; theſe two, meeting, form the upper lamina: and as, where the lower layer of the omentum comes off from the colon, it is alſo formed by the peritoneum reflected in the ſame manner; ſo with ſome truth the omentum is ſuppoſed to conſiſt of four lamina of membranes of extreme tenuity: but theſe four layers cannot be demonſtrated. The great omentum extends from the boſom of the ſpleen tranſverſely, until it terminates on the right ſide of the arch of the colon, where the omentum colicum begins.

* Præterea tenerrimas eſſe ut nulla membranarum humanarum, retina oculi excepta, æque ſit tenera.

Haller, vol. vi. lib. 20. § 1. par. 12.

While its delicacy is remarkable in the young ſubject, the retiform veſſels (vid. Ruyſch. Ther. II Q. V. Spegil. LVIII. &c.) have the fat accumulated in their tract as if it were thrown up by them to a ſide; but often the fat increaſing obſcures the veſſels.

† Marſupium the common term.—See Winſlow, IV. § 352.

The

The great omentum varies conſiderably in extent. In a child it is ſhort; in the adult further extended over the viſcera: ſometimes it reaches only to the umbilicus; ſometimes it is allowed to extend its margin into the pelvis, ſo that in old people it is very apt to form a part of the contents of hernia; often it is waſted and ſhrunk; ſometimes collected into maſſes leaving the ſurface of the inteſtines.

OF THE OMENTUM MINUS, OR HEPATICO GASTRICUM.

This is a membrane of the nature of that laſt mentioned, but in general leſs loaded with fat. It is extended from the liver to the leſſer arch of the ſtomach. It paſſes off from the lower ſurface of the liver at the tranſverſe foſſa; from the foſſa ductus venoſi; inveſts the lobulus ſpigellii; involves the branches of the cæliac artery; and is extended to the leſſer curvature of the ſtomach and the upper part of the duodenum*.

OMENTUM COLICUM.

This is a continuation of the great omentum upon the right ſide of the great arch of the colon, where it riſes from the caput coli; but it ſeldom extends its origin from the colon the length of the caput coli. It can be inflated like the great omentum.

APPENDICES EPIPLOICÆ, OR OMENTULA INTESTINI CROSSI.

These are little fatty and membranous proceſſes which hang pendulous from the ſurface of the colon: they are of the ſame texture and uſe with the greater omentum and right colic omentum.

We have mentioned that the omenta are double reflections from the peritoneum, and conſequently they may

* "Macilentius eſt, et vaſa habet minora." Winſlow. Haller. Indeed it ſeems rather to anſwer the general purpoſe of a cellular membrane conveying veſſels, than the purpoſes of the omentum majus.

may be inflated ſo as to demonſtrate them to be perfect facs. To do this it is not required to puncture any part of them, for there is a natural opening by which the whole may be inflated in a young ſubject, and in a healthy ſtate of the viſcera.

This natural opening into the purſe or ſac of the omentum is betwixt the membrane involving the veſſels and ducts of the liver, and the peritoneum, where it inveſts the vena cava betwixt the neck of the gall bladder and the firſt turn of the duodenum, or where the lobulus caudatus hepatis touches the duodenum. By introducing a blow pipe into this natural fiſſure the foramen of Winſlow, the omentum minus may be raiſed: the gaſtro colic, and colic omenta may be inflated. This opening ſerves as a communication betwixt the cavities of the omentum and the general peritoneal cavity; but I am inclined to think it is very frequently deſtroyed by adheſions *. As this opening points towards the right ſide, Dr. Monro thinks it a ſufficient reaſon for introducing the trochar on the right ſide in the operation of tapping for aſcites, (contrary to the uſual caution of avoiding the liver, which is ſo often diſeaſed in this caſe,) and that by operating on the left ſide he thinks the water will not be allowed to flow from the ſac of the omentum †. It appears to me that it will flow equally well from whatever point of the belly the water is drawn.

There is a conſiderable variety in the form of the omentum of animals ‡, but ſtill they ſeem to ſhew the ſame proviſion of involving the inteſtines, filling up the inequalities which ariſe from the rounded forms of the viſcera, and ſtill further lubricating and giving mobility to the inteſtines §. The ſurface of the omentum,

* Winſlow, Duverney, and Haller.

† *Quer.* If I ſhould ſay to a patient, By puncturing here I am in danger of thruſting this inſtrument into your liver; by introducing it here there is leſs poſſibility of any ſuch accident, though I may not draw off all the water; what would be her anſwer?

‡ Haller Element. Phyſiol. tom. vi. lib. xx. § 2 and 3.

§ We muſt not ſuppoſe that becauſe a mad-man ſtabs himſelf in the belly, and there is afterwards found coalition of the inteſtines to

tum, however, ſeems merely to furniſh a fluid exudation like the general ſurface of the peritoneum; and the idea which has been entertained of the oil or fat exuding is not true *.

The uſe aſſigned to the omentum of being ſubſervient to the function of the liver is deſervedly neglected †.

CHAP. II.

OF THE MEMBRANEOUS VISCERA OF THE ABDOMEN ‡.

HAVING underſtood the nature of the general inveſting membrane of the abdomen, and what is meant by its cavity and its proceſſes, we take a general ſurvey of the œconomy of the viſcera, before entering upon the minute ſtructure of the parts individually.

The organs deſtined to receive the food, and to perform the firſt of thoſe changes upon it which fit it (after a due ſucceſſion of actions) for becoming a component part of the living body, are the ſtomach and inteſtines primarily; the glandular viſcera, the liver, pancreas, (and in all likelihood the ſpleen,) as ſubſervient or ſecondary organs. I have been accuſtomed in my lec-

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to the wounds, the omentum has not done its office, (ſee Boerhaavii Prelectiones, vol. i. § 45) no more can we give credit to the tale told by Galen (De Uſu Partium, l. iv. c. 9.) of the gladiator who loſt part of the omentum, and ever after had a coldneſs in his guts! at leaſt we cut out a great part of the omentum from a man without any ſuch ſenſation being the conſequence now-a-days.

* "Et dum halitu pingui & ipſa obungit & peritoneum." Hale loc. cit. Boerhaave, &c. Morgagni Adverſar. III. Animad. VI.

† Viz. by ſupplying a groſs oily matter to the venæ portæ.

‡ Although the term Viſcus implies more particularly the fleſhy or ſolid contents, as the heart, liver, kidnies, yet we uſe it in general for all the parts contained in the great cavities.

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tures to divide thefe parts into the membranous or floating vifcera, (viz. the whole track of the inteftinal canal) and the glandular vifcera; or perhaps, what is ftill better, they may be diftinguifhed into thofe parts which have action and motion, and thofe which are quiefcent or poffeffed of no power of contraction. Thus the ftomach, inteftines, gall-bladder, and bladder of urine (though this belongs to the pelvis) have mufcular coats, and the power of contracting their cavities; while the liver, fpleen, pancreas, and kidnies, have no mufcularity but in their veffels and excretory ducts.

This divifion of the vifcera may lead to important diftinctions in pathology. During inflammation, it is obferved, that though the parts poffeffing a power of contraction may fometimes lie inactive without pain, yet in thofe parts when roufed to action there is excruciating pain. On the other hand, it often happens that the glandular and folid vifcera are the feat of long continued difeafe, which is attended only with a dull or low degree of pain; while the anatomift is often ftruck upon examining the body after death with the wide ravages of the difeafe.

We divide the inteftinal canal into three parts; the ftomach, the fmall inteftines, the great inteftines. The fmall inteftines are fubdivided into the duodenum, jejunum, and ileon. The great inteftines are fubdivided into the cæcum, colon, and rectum. The ftomach is the feat of the digeftive procefs: in the duodenum the food receives the addition of the fecretions from the liver and pancreas, and is ftill further changed; in the long tract of the jejunum and ileon the nutricious part is abforbed; and in the great inteftines the foul fediment becoming fæces is carried flowly forward, fuffers a further abforption of fluid, lodges in the lower part of the colon, and then in the rectum or laft divifion of the canal.

From this view it is apparent that each divifion of the inteftinal canal is marked by fome peculiarity in its ufe or function, we muft carefully examine their minute

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ſtructure as individual parts, at the ſame time that we do not allow ourſelves to forget the univerſal connection, the integrity of the circle of actions, and the œconomy as a whole. With this intention, following the courſe of the food, we treat firſt of the œſophagus.

SECTION I.

OF THE ŒSOPHAGUS.

THE œſophagus or gullet is a cylindrical muſcular tube, which conveys the food to the ſtomach. It is continued from the pharynx down behind the larynx and trachea and cloſe before the ſpine, and continuing its courſe in the back part of the thorax, it perforates the diaphragm, and expands into the upper orifice of the ſtomach.

Although with many authors I call it a cylindrical tube, and it may take this form when diſſected from the body and inflated, yet during life it lies collapſed with its inner membrane in cloſe contact, and it tranſmits the morſel only by the continued ſucceſſion of the contraction of its fleſhy coat.

The upper part of this tube is called the pharynx. It may be deſcribed as being expanded like a funnel; it is attached to the occipital bone, pterygoid proceſſes of the ſphenoid bone, and jaw bones; and further down it is kept expanded upon the horns or proceſſes of the os hyoidis. This bag is very fleſhy, being ſurrounded with muſcular fibres, which take their origin from the neighbouring fixed points; as the ſtyloid proceſs, the horns of the os hyoidis, the thyroid cartilage; by which it is enabled to graſp and contract upon the morſel when it has been thruſt by the tongue behind the iſthmus faucium. This ſtrong tiſſue of muſcular fibres which ſurrounds the pharynx, is continued down upon the œſophagus

phagus in the form of a ſheath, which has been called tunica vaginalis.

STRUCTURE OF THE ŒSOPHAGUS.

I believe we can with propriety enumerate no more than two proper coats of the œſophagus; its muſcular and internal coat: for that which is ſometimes conſidered as the outer coat, is only the adventitious cellular membrane, and the nervous coat is merely cellular tiſſue connecting the muſcular and inner coat.

The MUSCULAR COAT of the œſophagus greatly ſurpaſſes in ſtrength and in the coarſeneſs of its fibres any part of the whole tract of the inteſtinal canal. There may be very diſtinctly obſerved in it two layers of fibres; an external one conſiſting of ſtrong longitudinal fibres, and an internal one of circular fibres. Theſe lamina of fibres are more eaſily ſeparated from each other than thoſe in any other part of the body *. But an idea is entertained that the one ſet of fibres, the circular and internal ones, are for contracting the tube, and the outer ones for elongating and relaxing it. I believe on the other hand that they contract together, conducing to one end, deglutition †.

What is called the TUNICA NERVEA is the cellular connection betwixt the muſcular and inner coat, and is very lax, inſomuch that the muſcular coat and the inner coat are like two diſtinct tubes, the one contained within the other, and but ſlightly attached. This appear-

* It appears that the œſophagus can be ruptured in two ways: acroſs, by the tearing of the longitudinal fibres; and longitudinally, by the ſeparation of the longitudinal fibres. This, though a rare accident, takes place in violent vomiting or ſtraining to vomit; and, in the firſt inſtance, the tearing acroſs of the œſophagus ſeems to be the effect of the action of the diaphragm on the œſophagus. By this accident the fluids of the ſtomach are poured into the cavity of the thorax.

† See farther of the muſcular coat of the inteſtines. "It was at one time ſuppoſed that the muſcular fibres of the œſophagus had a ſpiral direction." See Verheyen, and Morgan. Adverſar. iii.

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ance is preſented particularly when the œſophagus is cut acroſs.

The INNER COAT of the œſophagus is ſoft and glandular; villi are deſcribed as being diſtinguiſhable on its ſurface, and it is inveſted witha very delicate cuticle which dulls the acute ſenſibility, and prevents pain in ſwallowing. It in every reſpect reſembles the lining membrane of the mouth. The power, however, which the œſophagus ſeems to poſſeſs of reſiſting heat depends not on the inſenſibility beſtowed by the cuticle, but is owing to the rapid deſcent of the hot ſolids or liquids ſwallowed; for when they happen to be detained in the gullet they produce a very intolerable pain. This inner coat has an exhaling ſurface, like the reſt of the body, with particular glands to ſecrete and pour out that mucus which lubricates the paſſage for the food *. The inner coat is capable of a great degree of diſtention, but it is not very elaſtic, or at leaſt contraction of the muſcular coat throws it into longitudinal folds or plicæ †.

In the neck, the œſophagus lying betwixt the cervical vertebræ and the trachea, is at the ſame time in a ſmall degree towards the left ſide. In the thorax it runs down betwixt the pleura of either ſide, where they form the poſterior mediaſtinum. Here, even when it deſcends upon the dorſal vertebræ, the œſophagus lies rather to the left ſide; it then paſſes under the arch of the aorta, but quickly eſcapes from under its compreſſion and riſes on the right ſide of the aorta, and as it paſſes further down it gets more and more before the aorta. This is ſufficiently apparent when we attend to the relation of the perforations in the diaphragm for tranſmitting the aorta and the œſophagus.

* Theſe glands ſuffer ulceration and ſchirrous hardening, and are a terrible cauſe of obſtruction to ſwallowing.

† Some part of the food lodging in the natural lacunæ of the æſophagus, or ſome ſolid body, as the ſtone of fruit being received into them, has been the cauſe of a ſac forming in the pharynx or œſophagus. And it has happened that ſuch a ſac, gradually and for years enlarging, has formed a bag, into which nearly the whole food, that ſhould have paſſed into the ſtomach, was received, ſo as to oppreſs the œſophagus and occaſion a lingering death. An example of this is to be ſeen in my muſeum.

 Behind

Behind the œſophagûs, in the thorax, there are one or two lymphatic glands, which were underſtood by Veſalius to belong to the œſophagus. What deceived him is an appearance generally to be obſerved in theſe glands. The lymphatics, or the ſmall branches of veins, are generally filled with a black matter, which, extending to the coats of the œſophagus, reſemble very much the ducts of the glands going to open into the œſophagus *.

The inner coat of the œſophagus ſhows ſo very different a texture from that of the ſtomach, and this difference is marked by ſo very abrupt a line, as ſufficiently to indicate that the fluids poured out from the œſophagus are very diſtinct from thoſe of the ſtomach, and have probably no digeſtive property.

SECTION II.

OF THE STOMACH.

How vital and important the ſtomach is, and how it ſtands related by connection of nerves and by ſympathy, ought to be above all obſerved by the pathologiſt. It will be or ſeem to be the ſeat of diſeaſe for years, and yet no appearance on diſſection. It is no leſs remarkable, that the ſtomach will be the ſeat of the moſt confirmed diſeaſe, with organic derangement apparent on diſſection, and yet it ſhall not have been diſcovered during life; while again a blow on the ſtomach kills inſtantly.

Seat, Form, Diſplacement of the Stomach.

The ſtomach lies under the margin of the ribs of the left ſide, and chiefly in the left hypochondrium. Its greater extremity is on the left ſide, in contact with the diaphragm;

* Theſe glands in the poſterior mediaſtinum are ſometimes diſeaſed, and enlarged ſo as to compreſs the œſophagus and to cauſe ſo permanent an obſtruction of deglutition as to occaſion death.

diaphragm; but towards the right, the ſhelving edge of the left lobe of the liver is betwixt it and the diaphragm. On the lower part it is, by the meſocolon and arch of the colon, divided from the ſmall inteſtines; and to the greater extremity the ſpleen is attached by veſſels and by the looſe intertexture of the omentum. The ſtomach may be ſaid to be a conical ſac; the extremities of which being made to approach each other, gives it the curve of a hunter's horn, and gives occaſion to the anatomiſt, in ſtrict deſcription, to remark theſe parts; the SUPERIOR or CARDIAC orifice into which the œſophagus expands; the LOWER or PYLORIC orifice, which leads into the duodenum: the LESSER AND GREATER CURVATURES of the ſtomach; and the great bag towards the left where the ſpleen is attached.

The leſſer curvature of the ſtomach extends from betwixt the two orifices; includes in its embrace the ſpine, the aorta, and the ſmall central lobe of the liver, while there is attached to it the leſſer omentum. The greater curvature of the ſtomach is the outline of its diſtended belly, which riſes above the arch of the colon, and is marked by the courſe of the gaſtro-epiploic veſſels.

When the ſtomach is diſtended the lower orifice is nearly on a level with the upper one; but when the ſtomach is allowed to ſubſide, it falls conſiderably lower; ſo that whilſt the ſtomach is lying acroſs the abdomen it is alſo tending obliquely downwards. The enſiform cartilage will be found to preſent commonly to the middle of the ſtomach; and the lower orifice, when in its natural ſituation, is oppoſite to the foſſa umbilicalis of the liver: the upper orifice is kept conſtantly in one place from the ſtricter connection of the œſophagus with the diaphragm.

Both orifices of the ſtomach preſent backward, eſpecially the upper one, while the lower one is pointed backward and downward. By the diſtention of the ſtomach the great arch is extended, the orifices are directed more backward and towards each other, and eſpecially the greater extremity draws upon the œſophagus. By theſe means I conceive that there is ſometimes produced a difficulty of the ſtomach diſcharging its contents when

 greatly

greatly diſtended, the orifices being in a great meaſure turned from the œſophagus and duodenum.

The ſtomach being liable to frequent varieties in its degree of diſtention, the natural relation of parts muſt frequently be altered. It ought to be particularly recollected, that in the living body the ſtomach is ſupported and bound up by the inteſtines; ſo that the great curve preſents: and the broad anterior ſurface which the ſtomach preſents in the dead body is turned directly upward, and the inferior downward *. By the collapſing of the ſtomach and the conſequent falling down of the liver ſome have explained the ſenſation of hunger, conceiving that the uneaſy ſenſation proceeds from the liver being allowed to hang upon the broad ligament †. From the great ſimplicity of mechanical explanation phyſicians have eagerly indulged in them, but it will in general be found, that when they are applied to the explanation of the phenomena of a living body they are inadmiſſible.

OF THE COATS OF THE STOMACH.

THE coats or membranes forming the ſtomach are, the outer, the muſcular, the nerous, the vilous, and the three cellular coats. For theſe ſubdiviſions, however, I ſee no uſe, nor are they authoriſed by the natural appearance of the coats of the ſtomach. When there is a diſtinction in texture, ſtructure, or function, and where theſe lamina can be ſeparated, we ſhould conſider them as coats; but a mere intermediate tiſſue of veſſels, or the connecting cellular membrane, are improperly conſidered as diſtinct tunics.

FIRST COAT.—From what has been already ſaid of the peritoneum, it will readily be allowed that the outer coat of the ſtomach is formed by the peritoneum; a coat common to all the inteſtines. Were this not ſufficiently

* Thus the gaſtro epiploic artery preſents directly forward. It has been wounded, and bled both into the ſtomach and outwardly. I ſhould conceive it poſſible in ſuch a caſe to tie the artery.

† Winſlow.

evident in itſelf, it might be aſcertained by diſſecting the peritoneum from the cardiac orifice of the ſtomach, where it will be found reflected from the diaphragm. This coat is firm, ſimple in its texture, having no apparent fibrous texture, and ſmooth on its outer ſurface, with many minute veſſels. Under the peritoneal coat is the firſt cellular coat, being in fact a ſhort cellular tiſſue betwixt the peritoneal coat and the muſcular coat.

Muscular coat. — The muſcular coat of the ſtomach conſiſts chiefly of two lamina of fibres; leſs diſtinct however than thoſe of the œſophagus, or, in other words, more cloſely and irregularly connected. One ſet of fibres runs longitudinally, that is, from the one orifice to the other; the other ſet runs encircling the ſtomach; yet there are ſuch irregularities that it is difficult in every place to recognize the two great and original diviſions of fibres; and on this account in general three ſtrata or ſeries of fibres are deſcribed *. For an example of this apparent irregularity, there comes down upon the flat ſide of the ſtomach an irregular faſciculus of fibres, apparently from the longitudinal fibres of the cardiac orifice, and continued from thoſe of the œſophagus, which yet take a courſe fairly encircling the ſtomach. They cannot be ſtrictly ſaid to belong to either the circular or longitudinal ſeries, and in many places thoſe which run longitudinally on the ſtomach ſeem to ſink and loſe themſelves amongſt the lower fibres, or are reflected into tranſverſe fibres.

Theſe muſcular fibres of the ſtomach do not run in an uninterrupted courſe, but ſplit, rejoin, and form a kind of retiform texture, through which the coats beneath are at intervals diſcernible. This ſtructure would appear to beſtow a greater power of contraction on the ſtomach. The ſtrong longitudinal fibres which are ſeen upon the œſophagus form the outer ſtratum of the muſcular coat of the ſtomach, and they extend from the

* The moſt general opinion is, that there are three layers of fibres in the ſtomach. Some deſcribe an external longitudinal ſeries; a middle tranſverſe ſtratum; and again the internal fibres running longitudinally. See Galeati Acad. de Bolgne.

S 4 œſophagus

œſophagus and cardiac orifice in a ſtellated form alongſt the upper curvature, and downward upon the great end or ſacculus ventriculi. Then we have to obſerve a ſet of circular fibres, which forming rings upon the great end, extend over all the ſtomach, like the circular fibres of the arteries. Theſe fibres do not each encircle the ſtomach entirely, but while their general direction is circular, they are ſo interwoven that no one faſciculus can be followed to a great extent. Theſe are called the TRANSVERSE FIBRES OR STRATUM; while the deepeſt ſtratum conſiſts of the continued circular fibres of the œſophagus. Theſe laſt fibres are ſtrong upon the cardiac orifice, and may be preſumed to form a kind of ſphincter; but they diminiſh as they are remote from the ſuperior orifice. The lower or pyloric orifice of the ſtomach, however, is more carefully guarded by muſcular fibres; having in the duplicature of the inner coats a diſtinct circular ring of muſcular fibres.

The cellular tiſſue, being intermingled with the muſcular fibres, connects and ſtrengthens them, and gives the appearance of little white lines interwoven with the muſcular fibres, and which ſome have deſcribed as ſmall tendons *. There is alſo to be obſerved a broad ligamentous band on the two flat ſurfaces of the ſtomach towards the pylorus. They are like the bands of the colon, but not nearly ſo ſtrong or evident. They are formed by the denſer nature of the cellular tiſſue, and more intimate union betwixt the firſt and ſecond coats.

OF THE ACTION OF THE MUSCULAR COAT.

UPON conſidering the weakneſs of the muſcular fibres of the ſtomach, and the membranous nature of the whole coats, it appears that the general action of the ſtomach is ſlow, regular, and by no means a forcible contraction; not an apparatus for triturating the food, but merely giving motion to its contents. But regarding the extreme ſenſibility of the ſtomach, and the gradual and regular ſucceſſion of action, much will be found that is worthy

* See Winſlow, ſect. viii. p. 57.

of

of attention *. It ſhould ſeem that the morſel is ſent down into the œſophagus by a ſucceſſion of actions, preceded by a perfect relaxation; and that when the food arrives at the ſuperior orifice of the ſtomach, by the ſame relaxation preceding the contraction, the muſcular fibres of the upper part of the ſtomach yield and receive the food compreſſed by the œſophagus. Attending to the form of the ſtomach, we ſee a proviſion for the reception of the food into the great ſacculated fundus on the left extremity. And here we ſhall find that there is a greater profuſion of veſſels for the ſecretion of the juices of the ſtomach, and a ſet of muſcular fibres, probably relaxing and yielding to receive the food, and excited to action only when the proceſs of digeſtion has been in part or entirely accompliſhed. Often, on diſſection, I ſee the ſac or left extremity of the ſtomach diſtended, when towards the right extremity it is like the inteſtine in form. Mr. Home, obſerving that it was ſometimes contracted in the middle, has on this founded an opinion regarding the uſe of the ſpleen, more remarkable for ingenuity than ſoundneſs. We have proof that when the food has remained the uſual time in the great ſac of the ſtomach, and comes in ſucceſſion to be preſented at the lower orifice, if the ſtomach is healthy and the change upon the food perfect, the lower orifice is relaxed, and yields to the contraction of the muſcular fibres of the ſtomach, and the contents of the ſtomach are paſſed into the duodenum: but if the food has been of an indigeſtible nature, it is rejected. The pyloric fibres refuſe the neceſſary relaxation, and by the unnatural excitement an antiperiſtaltic motion is produced, and the matter is again thrown into the great end of the ſtomach, or rejected by vomiting †. There is in the natural action of the ſtomach a ſtimulus, followed by a regular ſucceſſion of motion in its fibres, conveying the contents from the upper to the

* See Haller's Experiments. *Opera Minora,* Ventriculus Motus periſtalticus.

† It would ſeem that the upper orifice of the ſtomach has a power of contraction on unuſual ſtimulus applied. Haller loc. cit. Exp. ccciii.

lower

lower orifice of the ſtomach. Of this excitement and action we are not conſcious; but when the action is diſordered by an unuſual excitement, the lower orifice is not unlocked, the action becomes violent (the reverſe of what naturally takes place), and pain or uneaſy feelings are produced. Upon this principle may be explained the nauſea and vomiting which take place at certain times after eating, when balls or concretions are lodged in the ſtomach. While the food lies in the greater extremity, or in the body of the ſtomach, and the ball or concretion with it, there is no great excitement; but when it has ſuffered the neceſſary change, and is approaching to the pyloric orifice, this part, being as it were a guard upon the inteſtines, is ſuddenly excited, vomiting is produced, and the ball is thrown into its old place in the ſacculus or great end.

An attempt has been made to diſtinguiſh the affections of the ſtomach according as they proceed from the vitiated ſecretion, or the diſordered muſcular action. For example, it has been ſaid, if there is pain when the ſtomach is empty, then is it owing to the ſecretions of the ſtomach hurting the coat; if there be pain when the ſtomach is full, or at regular period after taking food, then is it proceeding from diſordered muſcular action. This is ſettling the whole difficulty on too eaſy terms. The function of the muſcular fibre and of the ſecreting veſſels are not thus diſtinct. The motion of the ſtomach itſelf and the ſecretions into it are actions conducing to a general reſult, and nature has ſecured the end by combining the means; and vitiated fluids poured into the ſtomach even by its own veſſels, are attended with irregular ſpaſmodic pains.

This great ſenſibility, producing effects almoſt like intelligence, is apparent in the more common diſorders of the ſtomach. We ſhall find the meteoriſmus ventriculi (the great diſtention of the ſtomach by flatus) exiſting for weeks, and yet the food paſſing in regular courſe through its orifices. We ſhall find very frequently food of difficult digeſtion lying in the ſtomach and oppreſſing its functions for days, while food more recently received may

may have undergone the actual changes, and have paſſed through the pylorus into the duodenum.

Owing to the ſame flow and ſucceſſive action of the ſtomach, it often happens that ulceration and ſchirrous pylorus, or other obſtruction of the lower orifice of the ſtomach, is attended with pain, nauſea and vomiting, only at ſtated intervals after taking food; *i. e.* at the time in which the food ſhould be ſent into the inteſtines in the natural courſe of action.

The muſcular fibres of the ſtomach are excited by ſtimuli, applied, not to their ſubſtance, but to the contiguous coats; and betwixt the delicate ſurface of the inner coat and the muſcular fibres there is the ſtricteſt ſympathy and connection. The ſame connection holds in a leſs intimate degree betwixt the outer coat and the muſcular fibres; for when a part on the ſurface of the ſtomach of a living animal is touched with acid or ſtimulating fluids, the part contracts *. The ſtomach is conſidered as leſs irritable than the inteſtines, becauſe it is alleged that a ſtronger doſe of a medicine is required to prove emetic than to act as a purgative: but we ought to conſider that the action thus excited in the inteſtines is merely an acceleration of their ſecretions; but vomiting is the interruption of the uſual action, requiring ſuch a violent excitement as to invert the natural action.

But there is ſomething more than this; as the function of the ſtomach differs from that of the inteſtines, ſo may the quickneſs of their action. Thus in the ſtomach a gradual change is to be produced upon the food, requiring time and a ſlow degree of motion; but in the inteſtines there is a greater agitation of their contents, and a quicker action of their coats, to bring the fluids into more general contact with the abſorbing ſurface, and to give greater activity probably to the abſorption by the lacteals. I am inclined to think that the ſtomach is the moſt irritable part of the body, and ſuſceptible of the

* "In ea ſede quà tangitur, contrahitur, ſulcuſque profundus naſcitur, et rugæ; cibuſque aliquando propellitur ut à ſede contracta fugiat. Minùs tamen quàm inteſtina ventriculus irritabilis eſt: hinc emetica fortiora neceſſe eſt purgantibus."—Haller.

moſt

moſt minute diſtinctions in the nature of the ſtimuli applied to it. The phenomena of the living animal, and experiments in thoſe recently killed, ſufficiently prove the contractile powers of the two orifices. Experiments have been made which ſhew the powers both of the cardiac and of the pyloric orifices in retaining the contents of the ſtomach after the œſophagus and duodenum have been cut acroſs. The ſtomach of a rabbit has been ſqueezed in the hand after cutting the duodenum, without any of its contents having eſcaped *; and in ſimilar experiments, the finger being introduced into the lower orifice of the ſtomach of an animal yet warm, the fibres of the pylorus were found to contract ſtrongly upon it. Upon forcibly compreſſing the ſtomach, the food will be made to paſs into the œſophagus much more readily than into the duodenum; which is another proof how neceſſary the natural ſeries of actions is to the relaxation of the pylorus.

Of vomiting.—When there is an unuſual or unnatural irritation on the ſtomach, or when it is violently ſtimulated or oppoſed in its natural courſe of action, the motion becomes inverted; and drawing by ſympathy other muſcles to its aid, the contents of the ſtomach are evacuated by vomiting. Thus where the food takes changes inconſiſtent with healthy digeſtion; or when ſolid matters lodge in the ſtomach; or when ſecretions of the duodenum paſs into the ſtomach, or unuſual actions are propagated backwards upon the ſtomach from the upper portion of the canal; or when emetics are taken, which are unuſual ſtimuli; or when there is inflammation in the ſtomach, which, from giving greater ſenſibility, produces the ſame effect with more violent ſtimuli; or when the coats are corroded or ulcerated; — vomiting is produced. That vomiting may be produced by the inverted motion of the ſtomach and œſophagus alone, is apparent from experiments upon living animals,

* See a paper in the 3d vol. of Sandifort, Theſ.
An excellent plate of the Pylorus given with this Diſſertation. — *Morgagni* Adverſar. III. IV. de Ventriculi Struct.

where

where the abdominal mufcles are laid open, and from cafes in which the ftomach has lain in the thorax, and yet been excited to active vomiting *. Again, it is equally evident that, when the ftomach is excited to vomiting, there is confent of the abdominal mufcles, by which they are brought into violent and fpafmodic action; not alternating in their action, as in the motion of refpiration, but acting fynchronoufly, fo as greatly to affift in compreffing the ftomach: but at the fame time, the action of thefe mufcles, however forcible their contraction, cannot alone caufe vomiting; nor has this action any tendency to produce fuch an effect on other occafions in which the utmoft contraction of the diaphragm and abdominal mufcles is required to the compreffion of the vifcera. Many have conceived that vomiting is entirely the effect of the action of the abdominal mufcles and diaphragm. Such, for example, has been the opinion not only of J. Hunter, but of Duverney, and of M. Chirac in Hift. de l'Acad. des Sciences, 1700. M. Littre oppofed this notion, and contended before the Academy, that the contraction of the diaphragm was the principal caufe of vomiting. M. Lieutaud in 1752 fupported the idea that vomiting is the effect of the action of the ftomach. He found, upon diffection, in a patient whofe ftomach had refifted every kind of emetic, that it was greatly diftended and become infenfible; and concluded that the want of action in the ftomach, and confequent lofs of the power of vomiting, was a ftrong proof of the action being the effect of the contraction of the ftomach only. There are other more curious inftances of difeafe of the ftomach preventing the mufcular contraction in any violent degree, and confequently the abfence of the ufual fymptom of vomiting: — an inftance of this kind will be feen in Dr. Stark's work. In my Mufeum I have a preparation of a ftomach, in which the walls had become fo thick that they could no longer fuffer contraction by the mufcular fibres; the confequence of which was that, although the

* See Wepfer de Cicuta Aquatica, p. 68. — Sauvage's Vomitus.

inner

inner coat of the ſtomach was in a raw and ulcerated ſtate, there was no active vomiting.

The ſingultus ſeems the partial exertion of the ſympathy betwixt the upper orifice of the ſtomach and the diaphragm, by which a kind of weak ſpaſmodic action is excited in it, but without a concomitant inverted action in the ſtomach and œſophagus. It is a convulſive and ſonorous inſpiration, owing to an irritation of the upper orifice of the ſtomach and œſophagus, but not exactly of that kind which cauſes inverſion of the natural actions of the ſtomach. Thus we have the ſingultus from gluttonous diſtention of the ſtomach, from ſome medicines and poiſons, from ſome crude aliment, or even from ſome foreign body ſticking low in the œſophagus, or from inflammation. The bourborigmi and rumination ſeem to be gentler inverted actions of the upper orifice of the ſtomach and œſopha gus, unaſſiſted by any great degree of compreſſion of the ſtomach by the abdominal muſcles and diaphragm.

The full action of vomiting is preceded by inſpiration, which ſeems a proviſion againſt the violent excitement of the glottis, and the danger of ſuffocation from the acrid matter of the ſtomach entering the wind-pipe; for by this means the expiration and convulſive cough accompanying or immediately following the action of vomiting, frees the larynx from the ejected matter of the ſtomach. But the action of the diaphragm is farther uſeful by acting upon the mediaſtinum, which embraces the œſophagus, and no doubt ſupports it in this violent action.

NERVOUS OR VASCULAR COAT OF THE STOMACH.

WHAT Haller calls the nervous coat, is the cellular ſtructure in which the veſſels and nerves of the ſtomach ramify and divide into that degree of minuteneſs which prepares them for paſſing into the innermoſt or villous coat. It may with equal propriety be called the nervous, the vaſcular, or the great cellular coat*. Taking it as the

* To call it cellular coat, however, would be to confound it with the three cellular coats generally enumerated by authors.

third

third diſtinct coat of the ſtomach, it is connected with the muſcular coat by the SECOND CELLULAR coat, and with the villous coat by the THIRD CELLULAR coat. Strictly, however, it is the ſame cellular membrane, taking here a looſer texture to allow of the free interchange and ramification of veſſels. When macerated, it ſwells and becomes like fine cotton, but has firmer and aponeurotic-like filaments interſecting it; it can be blown up ſo as to demonſtrate its cellular ſtructure *. It is in this coat that anatomiſts have found ſmall glandular bodies lodged, eſpecially towards the extremities or orifices of the ſtomach.

VILLOUS COAT. — This is the inner coat, in which the veſſels are finally diſtributed and organized to their particular end. It is of greater extent than the outer coats of the ſtomach; which neceſſarily throws it into folds or plicæ. Theſe folds take, in different animals, a variety of forms: but they are ſimple in man; from the œſophagus they are continued in a ſtellated form upon the orifice, but form no valve here. In the body of the ſtomach they are more irregular, ſometimes retiform, and ſometimes they form circles or ſquares, but they have generally a tendency to the longitudinal direction. In the pyloric orifice the villous coat forms a ring, called the valve of the pylorus, which, however, has no reſemblance to a valve in its form or action. This ring is not formed by the inner coat of the ſtomach alone, but by the inner ſtratum of fibres of the muſcular coat, the vaſcular and cellular coats, and the inner or villous coat. The effect of all theſe coats, reflected inward at the lower orifice, is to form a tumid and pretty thick ring, which appears like a perforated circular membrane when the ſtomach has been inflated and dried; but in neither ſtate is its direction oblique ſo as to act as a valve. It ſeems capable of reſiſting the egreſs of the food from the ſtomach, or the return of the matter from the duodenum, merely by the action of the circular fibres which are included in it.

* Winſlow, ſect. viii. p. 64.

On

On the ſurface of the inner coat of the ſtomach, ſmall retiform rugæ and a pile of innumerable villi are obſerved. But this ſtructure of the ſtomach has not been ſo fully examined, and is not ſo perfectly underſtood as the analagous appearance in the inteſtines. Glands are alſo deſcribed as opening upon the inner ſurface of the ſtomach: and thoſe who have not been able to ſee theſe glands, which are ſeated in the third cellular coat, yet believe in their exiſtence from analogy; while others obſerve foramina toward the upper and lower orifice of the ſtomach, which they ſuppoſe to be the opening or ducts of glands. Theſe, however, which I believe to be merely cryptæ or follicles, are themſelves the ſecreting ſurface, and not the ducts of the proper round glandular bodies; at the ſame time it muſt be admitted that diſeaſe, as if magnifying and giving ſize to the ſtructure of the ſtomach, ſhews a glandular and tuberculated ſtructure.

Gastric fluid. There is ſecreted into the ſtomach a fluid, which is the chief agent in digeſtion. The moſt common opinion is that it flows from the extreme arteries of the villous coat in general, partly from the mucous cryptæ and ducts. But I ſhould conſider theſe glands rather as analagous to the mucous follicles of the œſophagus and lower portion of the inteſtine, and merely as lubricating and defending the paſſages. I ſee no reaſon to ſuppoſe that the gaſtric juice can lodge or be retained in the coats or veſſels of the ſtomach, as has been imagined *. I think the minute veſſels of the ſtomach diſcharge it from the villous ſurface in the moment of its formation. We obſerve no ducts and cannot ſuppoſe that gaſtric juice can be contained in the ſecreting blood veſſels. When pure, it is a pellucid, mucilaginous liquor, a little ſalt and brackiſh to the taſte like moſt other ſecretions, and having the power of retarding putrefaction and diſſolving the food. It acts on thoſe ſubſtances which are nutritious to the animal, and which are peculiarly adapted to its habits. It has, conſequently, ſome variety of properties in different animals. The ſecreting powers of the

* By Dr. Adams and Mr. A. Burns.

ſtomach

ſtomach ſeem ſo far to accommodate themſelves to the food received into it, that the property of the gaſtric fluid is altered according to the nature of the food. This affords another argument in favour of a ſimple diet; ſince, in a variety of condiments received promiſcuouſly into the ſtomach, the chance is the greater of ſome ingredient becoming an offenſive load.

It ſeems to be a peculiarity in the human ſtomach, that it has a greater capacity for digeſting a variety of animal and vegetable bodies. But I ſhould at the ſame time conceive that the natural power of digeſting the ſimple and appropriate food is diminiſhed as the ſtomach gains the power of diſſolving a variety of ſubſtances *. In other creatures, a ſudden change of food is rejected, and the powers of the ſtomach are found incapable of acting duly on the aliment, though time ſo far accommodates the gaſtric fluid to the ingeſta that the animalization becomes perfect. Mr. Hunter ſpeaks of the power of cattle eating and digeſting their ſecundines †. I have ſeen the membranes coiled in the bowels of a cow; but I too haſtily concluded this to be the cauſe of death. I am corrected by the authority of Dr. Jenner and Dr. Adams. The fact is ſufficiently aſcertained, that the nature of the digeſtive proceſs may be ſo far altered that gramenivorous animals may be made to eat fleſh, and carnivorous animals brought to live upon vegetables. This fact throws us back from the ſimple idea which we ſhould be apt to entertain of the nature of the change produced by digeſtion, viz. that it is ſimply chemical. For we ſee that the nature of the ſolvent thrown out from the ſtomach, and its chemical properties, may be changed by an alteration

* Dr. Adams's experiments go to prove that the gaſtric juice is always the ſame. An early friend of mine, Dr. Cheyne, whoſe works on the diſeaſes of children have ſufficiently proved his minuteneſs and accuracy of obſervation, lately told me that on the principle here expreſſed he has been very ſucceſsful in humoring the delicate ſtomachs of his patients; he has found that two kinds of food received at once into the ſtomach will be rejected; when ſeparately, they will not diſorder the ſtomach.

† See Obſervations on Digeſtion.

in the action of the coats of the ſtomach. Thus we are baffled in our enquiries, and brought back to the conſideration of this living property, which can ſo accommodate itſelf to the nature of the aliment.

The gaſtric fluid has been collected from the ſtomachs of animals after death, by ſponges which the animal has been made to ſwallow, or which have been thruſt down into its ſtomach, incaſed in perforated tubes. And, laſtly, it has been obtained by exciting the animal to vomiting, when the ſtomach was empty; for the ſecretions of the ſtomach are then poured out unmixed with food *. Although by theſe means a fluid may be obtained which may properly be called the ſuccus gaſtricus, yet it muſt contain a mixture of the ſaliva, and ſecretions from the glands of the œſophagus and pharynx, with the glandular ſecretions of the ſtomach, and the general vaſcular ſecretion from the ſurface of the ſtomach. It is a fluid, then, upon which the chemiſt can operate with no hope of a ſucceſsful or uniform reſult. And indeed chemiſtry ſeems no farther to aſſiſt us in forming an accurate conception of the changes induced upon the fluids in the alimentary canal, than that the more perfect, but ſtill very deficient, experience of the modern chemiſt ſucceſsfully combats the ſpeculations of the chemiſts of former ages. For example; it was formerly ſuppoſed that digeſtion was a fermentation, and that this fermentation was communicated and propagated by the gaſtric juice. It is now found that the gaſtric juice has properties the reverſe of this; that it prevents the food from taking an acid or putrefactive fermentation; that it acts by corroding and diſſolving the bodies received into the ſtomach; and that it is itſelf at the ſame time converted into a new fluid, diſtinct in its properties †. It is almoſt ſuper-

* By Spallanzani.

† The moſt curious fact is that property of the coats of the ſtomach, or of the fluids lodging in the coats of the ſtomach, by which milk and the ſerum of the blood are coagulated. It has been found that a piece of the ſtomach will coagulate ſix or ſeven thouſand times its own weight of milk. This action ſeems a neceſſary preparation for digeſtion, which ſhews us that the moſt perfect and ſimply nutritious

ſuperfluous to obſerve *, that the gaſtric juice has no power of acting upon the coats of the ſtomach during life; whether this be owing to the property, in the living fibre, of reſiſtance to the action of the fluid, or that there is a ſecretion bedewing the ſurface, which prevents the action, it is not eaſy to ſay; but more probably it is owing to the reſiſtance to its action inherent in a living part †.

Mr. Hunter ſuppoſed it neceſſary that the animal ſhould be in health, immediately preceding death, in order that the ſecretion of the gaſtric juice may be natural, and capable of diſſolving the dead ſtomach: but in the plate I have given, ſhowing the effects of this proceſs, the child was emaciated by long illneſs.

OF DIGESTION. By trituration and maſtication, and the union of the ſaliva with food in the mouth, it is merely prepared for the more ready action of the ſtomach upon it. No farther change is induced upon it than the diviſion of its parts and the forming of a ſoft pulp. But in the ſtomach, the firſt of thoſe changes (probably the moſt material one) is performed, which by a ſucceſſion of actions fits the nutritious matter for being received into the circulation of the fluids of the living body, and for be-

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tious fluid is yet improper, without undergoing a change, to be received into the ſyſtem of veſſels. For example; milk and the white of eggs are firſt coagulated, and then paſs through the proceſs of digeſtion. See J. Hunter, Animal Œconomy, Obſervations on Digeſtion.

* I do think it a very ſelf-evident fact, notwithſtanding Dr. Adams's taunting manner of quoting theſe words. See that very intereſting work on *Morbid Poiſons*, preface, xxxvi.

† Mr. Hunter is one great authority on this ſubject, &c.

See alſo Morgagni Adverſ. III. A. XXIV.

Dr. Adams on Morbid Poiſons, preface; and Mr. A. Burns's, of Glaſgow, paper. Edin. Journal, Ap. 1810. Amongſt other curious facts ſtated by Mr. Burns is this, that he has found all the length of the alimentary canal diſſolved into a pulpy glutinous maſs. I may ſay that, connected with the diſcuſſion, there may enter a queſtion as to what is the cauſe of a tenderneſs ſometimes to be obſerved in all the membranes of the body. I have to-day examined the viſcera of a negro, where the inteſtines were particularly tender, but the pericardium and valves of the heart more remarkably ſo ſtill.

 coming

coming a component part of the animal. For now the gaſtric juice acting on this fluid maſs quickly diſſolves the digeſtible part, and entering into union with it produces a new fluid, which has been called chyme, a thick or viſcid and turbid fluid. The maſs has changed its ſenſible and chemical properties; it has ſuffered the full action of the ſtomach, and by the gradual and ſucceſſive muſcular action of the ſtomach it is ſent into the duodenum. The food is converted into chyme by the operation of the gaſtric fluid, by an operation peculiarly animal, a proceſs of life. And the converſion of the food into a new ſubſtance is unattended by any chemical change, ſtrictly ſpeaking, if by chemiſtry we underſtand the mutual influence of dead matters in forming compounds or ſeparating and extricating the conſtituent parts. Animal or vegetable matter in the heat and moiſture of the ſtomach would quickly fall into the fermentations; but the living proportion of the ſtomach prevents this. In this I ſpeak of the ſtomach in health; when weak, then the ſymptom announcing the diminiſhed power is the extrication of gas, or the formation of acids, with oppreſſion and uneaſy ſenſations. The contents of the ſtomach conſiſt of air (partly ſwallowed, partly extricated by chemical change, but ſtill more in all probability by the heat); of chyme; and of a groſſer part incapable of becoming nutritious, and the ſeparation of which from the chyme is accompliſhed by the action of the canal. Now the ſtomach being ſtimulated by fulneſs, by flatus, and more ſtill by the peculiar irritation of the food to which it is natural to ſuppoſe its ſenſibility is adapted, the muſcular coat is brought into action, and the contents of the ſtomach delivered into the duodenum. Here having additional ingredients, it is farther changed in its nature, and approximates more to that of the fluids circulating in the veſſels. It is called chyle; it has become a white milky fluid, which by the property of the living ſurface of the lous coat is ſeparated from the maſs, and abſorbed by the lacteal veſſels of the inteſtines *.

* See farther of the lacteal and abſorbent ſyſtem.

HUNGER

HUNGER AND THIRST. We are ſolicited to take food by the uneaſy ſenſation of hunger, and by the anticipation of the voluptuous ſating of the appetite, and by the pleaſures of the palate. Hunger is conſidered as the effect of the attrition of the ſenſible coats of the ſtomach upon each other by the periſtaltic motion of the ſtomach and compreſſion of the viſcera. This appears to be too mechanical an explanation. If the ſenſation proceeded merely from ſuch attrition of the coats of the ſtomach, food received into the ſtomach would be more likely to aggravate than to aſſuage the gnawing of hunger; to excite the action of the ſtomach would be to excite the appetite, and an irritable ſtomach would be attended with a voracious deſire of food. Something more than mere emptineſs is required to produce hunger. There appears to be a deficiency of the due ſtimulus to the ſtomach, and a conſequent uneaſy ſenſation which is allayed by fulneſs. Hunger does not appear to be occaſioned by ſtimulus, but by a want of due excitement, by which the irritability of the coats and action of the veſſels are as it were ſuffered to accumulate; and this tenſion, and irritation, and fulneſs of veſſels, is relieved by the food which excites the action, draws out the fluids, and gives activity to the ſyſtem of veſſels.

THIRST is ſeated in the tongue, fauces, œſophagus, and ſtomach. It depends on the ſtate of the ſecretions which bedew theſe parts, and ariſes either from a deficiency of ſecretion or from an unuſually acrid ſtate of it. It would appear to be placed as a monitor calling for the dilution of the fluids by drink, when they have been exhauſted by the fatigue of the body and by perſpiration, or when the contents of the ſtomach require to be made more fluid—the more eaſily to ſuffer the neceſſary changes of digeſtion.

The change on the ſecretion of the tongue and fauces from diſorder of the ſtomach, is not, I imagine, a conſequence of an influence communicated along the continuous ſurface. It has its origin in this natural conſtitution of the parts; this connection which nature has eſtabliſhed betwixt the ſtomach and tongue, betwixt the

 appetite

appetite and the neceffity of the fyftem. The ftate of the tongue, the loofe or vifcid fecretions of the throat and fauces, even the fecretion of the faliva, the irritability of the larynx, are influenced by the ftomach. The more permanent and demonftrable effects on the tongue are principally attended to; which perhaps is the reafon that we only fee by this that the ftomach is difordered, not how it is affected.

The cardiac orifice is the chief feat of all fenfations of the ftomach both natural and unufual, as it is the moft fenfible part of the ftomach. Indeed we might prefume this much by turning to the defcription and plates of the nerves; for we fhall find that this upper part of the ftomach is provided in a peculiar manner with nerves, the branches of the par vagum.

The fympathy of the ftomach with the reft of the inteftinal canal, the connection of the head and ftomach in their affections, the effect of the diforder of the ftomach on the action of the vafcular fyftem and of the fkin, and the ftrict confent and dependence betwixt the ftomach and diaphragm and lungs, and in a particular manner with the womb, tefticle, &c.—and again, the connection of the ftomach with the animal œconomy, as a whole,—muft not efcape the attention of the ftudent of medicine.

SECTION III.

OF THE SMALL INTESTINES.

The fmall inteftines are defcribed as that part of the inteftinal canal which is betwixt the pyloric orifice of the ftomach and the valve of the colon. They are reckoned in length at four or five times the height of the body: they form that part of the canal in which the digeftion is completed, and the nutritious fluids abforbed from the wafte of the ingefta. They are commonly fubdivided in-

to the duodenum, jejunum, and ileon; or more ſimply into the duodenum and inteſtinum tenue*.

OF THE DUODENUM.

The DUODENUM ſtands diſtinguiſhed from the general tract of the ſmall inteſtines by its ſhape, connections, and ſituation. It is greatly larger than any other part of the ſmall inteſtines; irregular and ſacculated; more fleſhy; and, although it has fewer plicæ, it is more glandular and more vaſcular: but its greateſt peculiarity, and that which muſt convince us of its importance in the animal œconomy, and of the neceſſity of attending to it in diſeaſe, is this, that it is the part which receives the biliary and pancreatic ducts, and in which a kind of ſecond ſtage of digeſtion takes place; and that by the diſorder of theſe ſecretions it muſt be primarily affected. The duodenum takes a courſe acroſs the ſpine from the orifice of the ſtomach until it touches the gall-bladder. Firſt it goes in a direction downward; then it paſſes upward till it touches the gall bladder; then making a ſudden turn it deſcends directly near to the right kidney, and is then involved in the lamina of the meſocolon; it then takes a ſweep towards the right ſide, obliquely acroſs the ſpine, and a little downward; it afterwards runs behind the head of the pancreas and the great veſſels paſſing to the ſmall inteſtines, betwixt the vena cava and the vena portæ; and then again toward the left of the aorta, but ſtill bound down by the root of the meſocolon†. This portion of the inteſtine receives its name from being uſually meaſured off twelve fingers breadth, or from five to ſix inches, from the orifice of the ſtomach. I have

* Haller.

† How comes it, then, ſeeing the acute turns of this inteſtine, that Ruyſch calls it "Inteſtinum digitale, vel inteſtinum rectum breviſſimum?" Adverſar. Anat. Decad. II.

See a good deſcription of the duodenum by M. Laurent Bonazzoli, in the Tranſactions of the Academy of Bologna. And the Diſſert. L. Clauſſen. de duodeni ſitu et nexu. Sandifort Theſ. V. III. Monro, Medical Eſſays.

 always

always preferred, however, a natural and not an arbitrary divifion, and have confidered that portion of the inteftines as duodenum, which is above the lower lamina of the mefocolon, or the point at which it emerges from the ftricture of the mefocolon. As in this extent, befides being tied down to the fpine by the mefocolon, it has the peritoneum reflected off from it at other points, we have to remark the ligamentum duodeni renale, ligamentum duodeni hepaticum.

Although we fhall prefently treat of the coats of the fmall inteftines in general, yet it may not be improper here to obferve what are announced as peculiarities in the coats of this firft divifion. The firft or peritoneal coat is imperfect, as muft already be underftood: for it does not inveft the whole circumference of the gut; it ties it down more clofely, or it merely contains it in its duplicature, while a greater profufion of cellular membrane accompanies this than the other divifions of the inteftines. The mufcular coat is ftronger than that of the jejunum and ileon; the plies formed by the inner coats, fmaller than thofe of the other part of the fmall inteftine, and having more of a glandular ftructure. At the lower part of the firft incurvation of the duodenum, the inner coat forms a particular procefs like to thofe which are called valvulæ conniventes; and in this will be difcovered the opening of the biliary duct, within which alfo the ductus pancreaticus generally opens.

It is not without fome reafon that anatomifts have confidered the duodenum as a fecond ftomach, calling it ventriculus fecundus, and fuccenturiatus; for there is here performed a change upon the food, converting the chyme (as they have chofen to call it,) which is formed in the ftomach, into perfect CHYLE. But to fuppofe that the chyme is perfected in the duodenum, is to fuppofe the biliary and pancreatic fecretions neceffary to the formation of chyle; a point which is not allowed: for many fuppofe that the bile is merely a ftimulus to the inteftines, holding a controul over their motions; others, that it is ufeful only in feparating the chyle from the excrement; or again, that the bile is decompofed, part entering

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tering into the compofition of the chyle, while the other goes into that of the fæces; it feems to beftow upon them a power of ftimulating the inteftinal canal in a greater degree; and as the chyle is formed occafionally without the prefence of bile, we may be induced the more readily to allow that the bile does not in the natural actions and relations of the fyftems enter into the compofition of the chyle. At all events, we fee that it is the bile which is the peculiar ftimulus of the inteftinal canal, and that when interrupted in its difcharge from the ducts, the motions of the belly are flow, and coftivenefs is the confequence.

We find that there are poured into the duodenum from the liver and pancreas, fecretions which have an extenfive effect on the fyftem of the vifcera; and we muft acknowledge that the derangement of thefe fecretions muft operate as a very frequent and powerful caufe of uneafinefs, and that the duodenum muft often be the feat of difeafe and diftreffing fymptoms. We may obferve that, from the courfe of the duodenum, pain in it fhould be felt under the feventh or eighth rib, paffing deep, feeming to be in the feat of the gall-bladder, and ftretching towards the right hypochondrium, and to the kidney, and again appearing as if on the loins. We may obferve farther, that from the connections of this portion of the inteftine, and from the manner in which it is braced down by the mefocolon, fpafm, when flatus is contained in it, will fometimes produce racking pains. Nay farther, when the irregularities of digeftion affect the duodenum, and fpafm and digeftion follow; the diftention caufes it to prefs upon the gall-bladder, and the preffure and excitement together caufe an irregular and often an immoderate flow of bile, which with the acrid ftate of the food produces anxieties and increafed pain, inverted motion, vomiting, and even cholera.

We muft not forget, that the inverted action of the ftomach draws quickly after it the inverted motion of the duodenum. It may be of confequence to attend to this

in

in the operation of an emetic, for the ſtomach will ſometimes appear to be diſcharging foul and bilious matter which we naturally may ſuppoſe to have been lodged in it, but which has actually flowed from the duodenum, or has even come recently from the ducts in conſequence of the operation of the vomit *.

From a defect in the natural degree of the ſtimulating power of the bile, it will accumulate in the duodenum, occaſioning anxiety and loſs of appetite, and even congeſtion of blood and a jaundiced ſkin; we may certainly affirm that theſe at leaſt are often connected. Such accumulation in the duodenum muſt be attended with a languid action of the whole canal, and inactivity of the abdominal viſcera, becauſe the periſtaltic motion is begun here in the natural action of the inteſtines; and if the proper ſtimulus be deficient here, ſo muſt it be in the whole ſyſtem of the viſcera. Hence the neceſſity of rouſing the activity of the liver by evacuating the whole canal.

I may further obſerve, that it has been the opinion of the moſt reſpectable old phyſicians, thoſe whoſe knowledge of diſeaſes has been drawn from an acquaintance with anatomy, from the frequent inſpection of dead bodies, and the obſervation of the ſymptoms during life, that the ſtudy of the diſeaſes connected with the duodenum is the moſt important which can occupy the attention of the medical inquirer †.

OF THE SMALL INTESTINES IN GENERAL.

The ſmall inteſtines, under the name of jejunum and ileon, occupy the ſpace in the middle and lower part of the abdomen, the great maſs forming convolutions in the umbilical region. The canal of the ſmall

* Indeed vomiting in conſequence of concuſſion and compreſſion upon the whole contents of the abdomen, and in a particular manner on the liver, affords moſt powerful means of operating upon the infarction and remora of the blood in the hepatic ſyſtem.

† See Sandifort, vol. iii. p. 288. See Hoffman.

inteſtines is gradually and imperceptibly diminiſhed in diameter as it is removed from the lower orifice of the ſtomach ; ſo that the termination of the ileon in the caput coli is conſiderably ſmaller than the duodenum. This tract of the ſmall inteſtines performs the moſt important function of the chylipoëtic viſcera (if any can be ſaid to be peculiarly important where the whole is ſo ſtrictly connected) ; for here the food is moved ſlowly onward through a length of inteſtine more than four times the length of the body *, and expoſed to a ſurface amazingly extended by the pendulous and looſe duplicatures of the inner coat. Here the fæces are gradually ſeparated from the chyle, and the chyle adhering to the villi is abſorbed and carried into the ſyſtem of veſſels.

The JEJUNUM † is the upper portion of the ſmall inteſtine. Its extent is two-fifths of the whole. Its convolutions are formed in the umbilical region.

The ILEON lies in the epigaſtric and iliac regions, ſurrounds the jejunum on the ſides and lower part, and forms three-fiths of the whole extent of the inteſtine from the meſocolon to the valve of the colon. The coats of the ileon are generally deſcribed as thinner and paler ; the valvular projections of the inner coat leſs conſpicuous ; and the mucous glands are apparent in the lower portion. The ſeveral parts of the ſmall inteſtines, which we may comprehend under the name of the long inteſtine ‡, do not preſerve a very exact relation in regard to their place in the belly, but in their motions they may be drawn to the right or left, upward or downward. This however I am convinced takes place in a much leſs degree than is generally believed.

* The whole length of the inteſtinal canal is generally eſtimated at from ſix to ſeven times the length of the whole body.

† So named from its being more generally empty.

‡ We may then ſpeak of the ſmall inteſtines in general, meaning the whole tract from the ſtomach to the great inteſtine ; the duodenum being the ſpace betwixt the ſtomach and the lower lamina of the meſocolon, the long inteſtine being the tract extending from the duodenum to the colon.

There

There is ſometimes found a luſus in the lower part of the ileon before it paſſes into the colon; a blind pouch or cæcum is, as it were, attached to the ileon reſembling the caput coli. I have found three inſtances of this. Sometimes there is more than one cæcum in the courſe of the ileon *.

MINUTE STRUCTURE OF THE SMALL INTESTINES.

We have in ſome meaſure anticipated the general enumeration and character of the coats of the inteſtines, by what has been ſaid upon the coats of the ſtomach; for we have here to diſtinguiſh the four great coats, the peritoneal, the muſcular, the vaſcular, and villous coats.

THE PERITONEAL COAT AND MESENTERY.

The peritoneal coat of the ſmall inteſtines is of the ſame nature with that of the ſtomach, liver, ſpleen, &c. It is a thin, ſmooth, pellucid membrane. On the ſurface it has a moiſture exuding from its pores; and it firmly adheres to the muſcular fibres beneath. Its tranſparency makes the muſcular fibres, blood-veſſels, and lymphatics eaſily diſtinguiſhable; and when it is diſſected or torn up, the longitudinal muſcular fibres will be found in general attached to it. Its uſe is to give a ſmooth ſurface and ſtrengthen the inteſtine, and in a great meaſure to limit the degree of this diſtention.

The peritoneal coat of the inteſtine is continued and reflected off upon the veſſels and nerves which take their courſe to the inteſtine: or, what is the ſame thing, and indeed is the more common deſcription, the two lamina of the peritoneum which form the meſentery, after pro-

* The appendices cæcales of the ileon have given birth to a curious queſtion in the pathology of hernia. See "Hernia ab ilii diverticulo." Morgagni, Adv. Anat. III. "Hernie formée par l'appendice de l'ileon." LITTRE, Mem. de l'Acad. Royale des Sciences, an 1700; Ruyſch, Palfin, &c. See caſes of anus at the groin in the Muſeum, Surgeons' Square.

ceeding

ceeding from the ſpine and including the veſſels, nerves, and glands belonging to the tract of the inteſtine, inveſt the cylinder of the inteſtine under the name of peritoneal coat *. The meſentery is compoſed of membranes, glands, fat, and the ſeveral ſyſtems of veſſels, arteries, veins, lacteals, and nerves. As in reality it is a production of the peritoneum, it may be ſaid to ariſe from the meſocolon, or the meſocolon from the meſentery, reciprocally. But at preſent we may trace the meſentery from the root of the meſocolon; — for the jejunum, emerging from under the embrace of the meſocolon, carries forward the peritoneum with it; and the laminæ of the peritoneum, meeting behind the gut, include the veſſels which paſs to it and form the meſentery. This connection of the ſmall inteſtines by means of the prolongation of the peritoneum, while it allows a conſiderable latitude of motion, preſerves the convolutions in their relations, and prevents them from being twiſted or involved. But it is by the walls of the abdomen that the inteſtines as well as the more ſolid viſcera are ſupported; for when the bowels eſcape by a wound, a portion of an inteſtine will hang down upon the thigh, unreſtrained by the connection with the meſentery.

The meſentery begins at the laſt turn of the duodenum, or beginning of the jejunum. Its root runs obliquely from left to right acroſs the ſpine. Here it has no great extent; but as it is prolonged toward the inteſtines, it ſpreads like a fan, ſo that its utmoſt margin is of very great extent; which may be conceived when we conſider that it is attached to the whole extent of the ſmall inteſtines. In the middle of the ſmall inteſtine, the meſentery has its greateſt extent or breadth; towards the beginning of the duodenum and the termination of the ilion, it is ſhorter, and more cloſely binds down the inteſtine.

* See Plate I. 5, 6, 7, 8.

MUSCULAR

MUSCULAR COAT OF THE INTESTINES.

There is not a more important point of consideration in the anatomy of the viscera, than this of the action of the muscular coat. The appearance and course of the fibres shall first be described, then their action, and lastly their effect in disease.

The peritoneum is united to the muscular coat by a very delicate and dense cellular membrane; which in the enumeration of the coats we must call the first cellular coat, but which really does not deserve the name of a distinct coat; for, as already said, the outer lamina of the muscular coat is raised with the peritoneum, and adheres intimately to it. The fibres of the muscular coat of the intestines are simpler than those of the stomach; for here there are only two sets of fibres, the longitudinal and circular fibres. The outer stratum consists of the very minute and delicate longitudinal fibres. Indeed, when the system has been exhausted by a long and debilitating illness with scarcely any excitement of the intestinal canal, these fibres are not to be observed. In a man who has been cut suddenly off by disease, or who has died a violent death, they become more demonstrable; and in diseases where there has been congestion and excited action in the intestines, they are of course still stronger and more discernible. The internal stratum of the muscular fibres is much stronger and more easily demonstrated. These fibres will be observed much stronger about the duodenum and upper part of the jejunum, but they become weaker and more pellucid towards the extremity of the ileon. Tracing any particular fibre of the circular stratum, it is found to form only a segment of a circle, a part of the circuti of the intestine. It seems lost amongst neighbouring fibres or cellular connections; but still, taken together, the circular muscular fibres uniformly surround the whole gut *.

To account for that action of the intestines which urges on the food, we may suppose a greater degree of

* Morgagni Adversaria Anatomica III. Animadversio V.

irritability

irritability and activity to reside in the upper portion, where of course is commenced that action which is successively propagated downwards, carrying the fæces into the lower part of the canal. Some anatomists have ingeniously imagined that the inner stratum of fibres surrounds the intestine not in a circular direction, as was asserted by Willis, but obliquely and in a spiral course; from which followed a simple explanation of their effect, since the contraction of the fibre winding lower in the intestine, pursued the contents with a uniform, progressive constriction.

Physiologists have made a distinction in the motion which they have observed in the intestines of living animals. The one they call the vermicular, and the other the peristaltic motion. Upon looking into the belly of a living animal, or of one newly killed, there may be observed a motion among the intestines, a drawing-in of one part and a distention and elongation of another part of the convolution. This motion has some resemblance to the creeping undulating motion of a reptile, and has got the name of vermicular motion. On the other hand, the direct contraction of the gut by the constriction of the circular fibres is the peristaltic motion. We must not however allow ourselves, from the loose expression of authors, to imagine, that these circular straight fibres act separately: on the contrary, excited by the same stimulus, they have a simultaneous motion to the effect of accomplishing the perfect contraction of the gut and motion of its contents*.

While the stimulus is natural, the contraction of the muscular coat is in a regular series from above downward, and, the lower part contracting before the upper is completely relaxed, the food must be urged downwards into the lower portion. I should even imagine that the lower portion is relaxed, from its more usual

* Neither can I allow that the acting of the longitudinal fibres in one portion of an intestine dilates that which is below, otherwise than through the compression of food and flatus.

degree

degree of tenſion, or ſlighter permanent degree of action *.

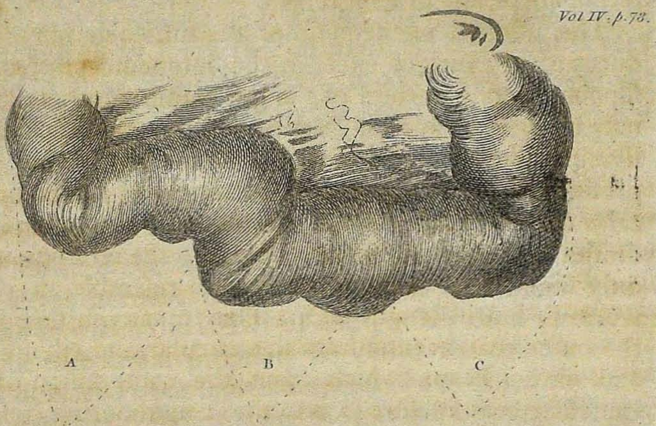
ANTIPERISTALTIC MOTION.

When the ſucceſſive contraction of the muſcular fibres of the inteſtines is oppoſed in its natural courſe downward, either by a violent ſtimulus (the effect of which is to cauſe a more permanent contraction in the coats, and one which does not readily yield to the relaxation that follows, as in the natural contraction), or when there is a mechanical and obſtinate interruption to the contents of the bowels; then is the natural action reverſed. This antiperiſtaltic motion muſt ariſe thus; a portion of the inteſtine being conſtricted, and not yielding to the contraction which in the natural action of the gut ſhould follow in order, the motion of the gut muſt be ſtationary for a time, until the part above is again relaxed; when, the contents of the inteſtine finding a free paſſage upwards, and that portion contracting and propelling the matter ſtill upwards and retrogade, (ſince it is oppoſed by the contraction below,) a ſeries of retrogade or antiperiſtaltic motions are produced. The courſe of the action is changed; the contraction of the gut is not followed by the dilatation of the part below, but by that of the part above. By this means the matter of the lower portion of the inteſtinal canal is carried into the upper part, and there acting as an unuſual ſtimulus, it aggravates and perpetuates the unnatural action. Nay, from experiments it appears that a permanent irritation will cauſe an accelerated motion in both directions, that from the point ſtimulated there will proceed downward the

* From the experiment of Haller and of others, it is proved that the irritability of the inteſtines long ſurvives that of the heart: that the inteſtines are in general in lively motion, when no motion can be obſerved in the ſtomach: but that ſometimes the motion of the ſtomach continues longer than that of the inteſtines. It is proved alſo that the action of the inteſtine is adequate to the motion downward and the diſcharge of fæces, without the aid of the abdominal muſcles. See *Mem. par Haller ſur les Mouvemens des Inteſtines*; and *Opera Minora*, p. 393.

regular

regular ſeries of contractions and dilatations, while the motion is ſent upwards and retrograde from the ſame point of the inteſtine toward the ſtomach *. And this obſervation, the exhibition of medicine and the diſeaſes of the inteſtines confirm. But farther we may obſerve, that the food is not uniformly moved downward; it is ſhifted and agitated by an occaſional retrograde motion thus:



The portion of the inteſtine included under A contracts and ſends its contents into B. B contracting ſends its fluid contents in part backward into A, but in a greater proportion into C. While the contents of the middle portion are ſent into the lower part in a greater proportion than into the higher diviſion, the tendency of the food will be in its natural courſe, downward; whilſt at the ſame time it ſuffers an alternate motion backward and forward; ſo that it is more extenſively applied to the abſorbing ſurface of the inteſtines.

The ſtimulus to the inteſtines is matter applied to their inner coat; and although there is much ſympathy in the whole canal, yet unleſs there be matter within a portion of the canal, that particular part has little action. Accordingly, when there is obſtruction to the courſe of the

* Haller, loc. cit., Exper. 424.

 aliment,

aliment, by whatever cause it may be produced, the portion below becomes shrunk and pale, and free from the effects of inflammation; while that stimulated by the food, being in a high state of excitement, irritated by the presence of matter which it is unable to send forward evacuated only partially by an unnatural and highly excited retrograde action, it becomes large, thick in its coats, strong in its muscular fibres, and greatly inflamed, till it terminate at last in gangrene *.

The unusual excitement of the muscular fibres produces a very curious effect in the intus-susceptio, or the slipping of one portion of the gut within another. This may be done by applying acrid matter to the intestines of living animals; and I have no doubt that it has been produced by giving purges too strong and stimulating in cases of obstruction of the bowels. By the contractions of the muscular coat greatly excited, the intestine is not only diminished in diameter so as to resemble an earth-worm †, but in length also. This great contraction of the outer coats accumulates the vascular and villous coat as if into a heap; which from the compression of the muscular coat is forced into the neighbouring relaxed portion. This first step leads only to a succession of actions; for the fibres of the relaxed or uncontracted part, sensible to the presence of this accumulated and turgid villous coat, contracts in succession so as to draw a part of the contracted gut within the relaxed portion. If the irritation is done away or ceases quickly, as in the experiments on animals, another turn of the intestine

* Haguenot gives an experiment illustrating the cause of ileus. He tied a ligature about the intestine of a cat, and found no antiperistaltic motion excited. This is not wonderful; it is the excitement arising from matter within the gut, to which there is no exit, and not the stricture of it, which is the cause of the violent symptoms.—A case in the Museum will give the young student a correct judgment on this subject.

Vide Scholium sub tit. Calculus insignis Ilii. Observ. F. Biumi. Sandif. Thes. vol. iii

† See Haller's Experiments, *Opera Minora*; and "Dissections of the Atrophia Ablactatorum;" with plates; by Dr. Cheyne. Sandifort, vol. ii. p. 381. in Dysentariæ. — Ibid. 244.

coming

coming into play diſtends this, and undoes the intus-ſuſceptio. But if the cauſe continues, the intus-ſuſceptio is continued; the included part of the gut is farther forced into the other. By theſe means the veſſels going to the included part are interrupted; the villous coat ſwells more and more; and ſeveral feet of the upper portion of the inteſtine is often in this way ſwallowed down. It is not however in the natural courſe downward that this preternatural action always proceeds; for, as the excitement is violent and unlike the uſual ſtimulus of food, and as we know that an unuſual excitement is very apt to cauſe an inverted action, it often happens that the intus-ſuſception is formed by the lower portion of the gut included in the upper part.

VASCULAR COAT.

This third coat of the inteſtines, or what is commonly called the nervous coat, is a ſtratum of cellular membrane in which the veſſels of the gut are diſtributed. It might with equal propriety be called the cellular coat; and is indeed what ſome anatomiſts have called the third cellular coat. By inverting the gut and blowing ſtrongly into it, the peritoneal coat cracks and allows the air to eſcape into this coat; which then ſwells out, demonſtrating its ſtructure to be completely cellular *. Its uſe evidently is to ſuffer the arteries, veins, and lymphatics to be diſtributed to ſuch a degree of minuteneſs as to prepare them for reflection into the laſt, and innermoſt coat, and for entering into the ſtructure of the villi: for they come to the extremity of the meſentery as conſiderable branches, but forming in this coat many branches, and theſe ſubdividing, their extreme branches are finally diſtributed to the inner coat. This is the coat in which, in ſome parts of the inteſtines, little glands or cryptæ are lodged.

* An experiment to which Albinus attaches much importance. See alſo, in the Acad. de Bologna, a paper by Mr. D. G. Galeati on the fleſhy coat of the ſtomach and inteſtines.

VILLOUS COAT.

The moſt curious part of the ſtructure of the inteſtines is the villous or inner coat; for by its influence is the chyle ſeparated from the general maſs of matter in the bowels, and carried into the ſyſtem of veſſels. To this all we have been deſcribing is merely ſubſervient.

The villous coat has a ſoft fleecy ſurface; and being of greater extent than the other and more outward coats, it is thrown into circular plaits which hang into the inteſtine, taking a valvular form. They have the name of VALVULÆ CONNIVENTES. Some of them go quite round the inſide of the inteſtine; others only in part. They are of larger or ſmaller extent in different parts of the canal: for example; they begin a very little way from the lower orifice of the ſtomach irregularly, and tending to the longitudinal direction; further down they become broader, more numerous, and nearly parallel; they are of greater length, and more frequent in the lower part of the duodenum and upper part of the jejunum. Theſe valvular projections have their edges quite looſe and floating in the canal, and from this it is evident that they can have no valvular action. Their uſe is to increaſe the ſurface expoſed to the aliment; to enlarge the abſorbing ſurface; and at the ſame time to give to it ſuch an irregularity that the chyle may lodge in it and be detained *. Into the ſtructure of theſe plicæ of the villous coat, the vaſcular or cellular coat enters, and generally in the duplicature a ſmall arterial and venous trunk will be obſerved to run. That theſe plicæ are formed chiefly by the laxity of the connection and the greater relative extent of the inner coat, is apparent upon inverting the gut, and inſinuating a blow-pipe under it, for then you may diſtend the cellular ſubſtance of the vaſcular coat ſo as entirely to do away the valvulæ conniventes.

* "Superficies internæ hujus tunicæ ad menſuram geometricam, aliquoties integumentorum communium ſuperficiem amplitudine ſuperat." Soemmering, vol. vi. p. 295.

The

The pile or lanuginous ſurface from which this coat has its name, is to be ſeen only by a very narrow inſpection, or with the magnifying glaſs. It is owing to innumerable ſmall filaments which project from the ſurface like hairs at firſt view, but of a flat or rounded figure as the ſtate of fulneſs and excitement or depletion ſhows them. They conſiſt (as appears by the microſcope) of an artery and vein, and lacteal or abſorbing veſſels, and to theſe we may ſurely add the extremity of the nerve. They have a cellular ſtructure; they are exquiſitely ſenſible; and when ſtimulated by the preſence of fluids in the inteſtines, are erected and abſorb the chyle. They are the extremities of the lacteal abſorbing ſyſtem, and their ſtructure would ſeem to be ſubſervient to the abſorption by the mouth of the lacteal veſſel *.

Reflecting on the fact that poiſons are abſorbed by the lacteals, we may be led too haſtily to conclude that the abſorption is independent of the ſenſibility of this villous coat, and that all fluids to which the mouths of the lacteals are expoſed, muſt be abſorbed. I believe on the contrary, that here the abſorption is connected with the ſtate of excitement, and that excitement with the healthy ſtate of the contents of the gut. I cannot deny that abſorption takes place hurtful to life, more than I can deny that action of the ſtomach takes place when it is diſordered by the matter contained in it. I only believe that there is a relation betwixt the natural excitement and the healthy action of the ſtomach, the natural excitement and due and healthy abſorption by the veſſels of the villi; nor can I ſee otherways how the chyle is abſorbed and the effete matters carried downward in the canal, unleſs there be a ſenſibility in the villi, holding a correſpondence with the matter in contact with them, as are exiſting in the papillæ of taſte on the tongue.

But the ſurface of this coat is not only an abſorbing one, it alſo pours out a ſecretion; and indeed it is as a ſecreting ſurface, upon which medicines can act, that it

* See further of their ſtructure under the title of the LACTEAL and LYMPHATIC SYSTEM, where the ſubject of abſorption and the ſtructure of the villi is treated.

is to us one of the moſt powerful means of acting upon the ſyſtem in diſeaſe. The fluid which is ſupplied by the ſurface of the inteſtines is called the liquor intericus; a watery and ſemipellucid fluid, reſembling the gaſtric fluid. This fluid phyſiologiſts have affected to diſtinguiſh from the mucous ſecretion of the glands of the inner ſurface of the inteſtines; but it is impoſſible to procure them ſeparate *.

GLANDS.

Anatomiſts have obſerved ſmall mucous glands ſeated in the cellular membrane of the inteſtines †, the ducts of which they deſcribe as opening on the villous ſurface of the inteſtines. They are ſeen as little opaque ſpots when the inteſtine is cut in its length and held betwixt the eye and the light. They have been chiefly obſerved in the duodenum; few of them in the general tract of the ſmall inteſtines. Little collections or agmina are obſerved, which increaſe in frequency toward the extremity of the ileon. It is natural to ſuppoſe that as the contents of the inteſtines become in their deſcent more acrid and ſtimulating, there will be a more copious ſecretion of mucus in the lower inteſtines for the defence of the villous coat.

* It has been ſuppoſed that the fluids excreted from the ſurface of the inteſtines were furniſhed by very minute foramina (which are viſible by particular preparation) in the interſtices of the villi. See the letter of Malpighi to the Royal Society of London on the pores of the ſtomach; and the paper by M. Galeati in the Bologna tranſactions on the Inner Coat, which he calls the Cribriform Coat. Theſe pores according to Galeati, are viſible through the whole tract of the canal, and particularly in the great inteſtines.

† Peyruſ. Biblio. Manget. Brunnerus de glandulis duodeni. Morgagni Adverſar. An. iii. viii. Theſe he ſuppoſed additional pancreatic glands.

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SECTION IV.

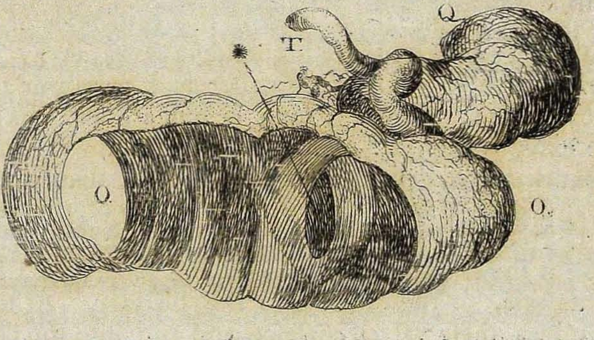
OF THE GREAT INTESTINES.

THE great inteſtines form that part of the inteſtinal canal which is betwixt the extremity of the ileon and the anus. They differ eſſentially from the ſmall inteſtines in their ſize, form and general character; and in the texture, or at leaſt in the thickneſs of their coats.

The great inteſtine, beginning on the right ſide of the belly, riſes before the kidney; paſſes acroſs the upper part of the belly under the liver, and before or under the ſtomach *. Then making a ſudden angle from under the ſtomach and ſpleen †, it deſcends into the left iliac region. Here making a remarkable turn and convolution, it deſcends into the pelvis by a curve running in the hollow of the ſacrum.

The great inteſtines are accounted to be about ſeven feet in length, and to bear a relation to the ſmall inteſtines as five to twenty-five.

The natural diviſion of this portion of the inteſtine is into the cœcum, colon and rectum ‡.



* This turn of the colon from the right acroſs the belly is flexura prima, ſuperior dextra hepatica Soemmering.

† Flexura ſecunda, ſuperior ſiniſtra lienalis.

‡ Some authors divide the great inteſtine into ſix parts, enumerating the cœcum; pars vermiformis; the right; the left; and the tranſverſe colon; and the laſt part or rectum.

VALVULA COLI *.

The extremity of the inteſtinum ileon enters as it were into the ſide of the great inteſtine at an angle †. And here there is a valvular apparatus formed by the inner membrane of the gut which, more than any other circumſtance, marks the diſtinction betwixt the ſmall and great inteſtines; for as the effect of this valve is to prevent the regurgitation of the fæces into the ſmall inteſtines, it marks ſufficiently the nature of the change produced on the injeſta in their paſſage through the ſmall inteſtine, and how unfit, in their changed and acrid ſtate, they are to be longer allowed lodgment there.

Upon opening the caput coli, or lower part of the colon, on the right ſide, and examining the opening of the ileon into it, we ſee a ſlit formed betwixt two ſoft tumid plicæ of the inner membrane of the gut: the one of theſe is ſuperior; the other inferior. They are ſoft, and moveable, and ſeem ſcarcely calculated for a valvular action. But there is little doubt that when the great gut is diſtended or in action, they are calculated to reſiſt the retrograde paſſage of the fæces into the ileon, though not abſolutely to prevent it, as we know from what is vomited in the iliac paſſion ‡. In the form of the opening of the ileon, and in the broadneſs of the valvular membranes, there is conſiderable variety. The ſuperior valve is tranſverſe, ſmaller and narrower than the lower one; the lower one is longer, and takes a more extenſive curve: and ſometimes the lower one is ſo remarkably larger than the upper valve, that it gives a great degree of obliquity to the inſertion of the ileon into the colon, ſo as to approach to that ſtructure which we ſee in the entrance of ducts, as the biliary duct into the inteſtine, or the ureter into the bladder. At their extremities theſe valves coaleſce and run into the com-

* *Valvula Coli* or *Valvula Bauhini. Valvula Tulpii.*

† Of the opening of the ſmall inteſtine into the greater, ſee Morgagni Adverſar. iii. Animad. xi.

‡ *Morg. Advers.* A. iii. An. ix. *Kerckringius Obſerv.* xxxi.

mon

mon tranfverfe folds of the colon: and this is what Morgagni has called the fræna or retinacula *. At this place of union of the ileon and colon the longitudinal mufcular fibres of the ileon are mingled and confounded with the circular fibres of the colon †. The circular mufcular fibres certainly enter fo far into the compofition of the valve, that they embrace the margin, and by contracting during life, muft make the experiments on the action of this valve in the dead body lefs decifive than they would be were we certain that this valve acts on principles ftrictly mechanical.

The difcovery of the valve of the colon, and which, from its action in guarding the ileon might rather be called the valve of the ileon, has been claimed or attributed to many anatomifts, chiefly to Varolius, Bauhin, and Tulpius; and it fometimes receives the name of the two latter anatomifts.

CŒCUM.

We have feen that the ileon is inferted into the fide of the colon: now that portion of the gut which is below this union of the ileon is a round or flightly conical fac, from two to three inches in length. It is attached by cellular membrane to the iliacus internus mufcle. It is not a regular fac, but is divided into large cells like thofe in the reft of the colon, and has fome variety of form in different fubjects.

PROCESSUS, SEU APPENDIX VERMIFORMIS.

There is appended to the cœcum a fmall gut, alfo blind; but bearing no relation in fize or in figure to any part of the inteftinal canal. This gut, from its fmallnefs and twifted appearance, like the writhing of an earthworm, has received the name of vermiformis. It is fomewhat wider at the connection with the great inteftine, and ftands off obliquely, fo that fometimes its inner

* Animad. xiii. † Winflow.

mem-

membrane takes the form of a valve *. It ſcarcely ever is found containing fæces, but only a mucus excreted from its glands. In the fœtus the appendix vermiformis is comparatively much larger, its baſe wider; upon the whole, more conical, and containing meconium; and in the young child it often contains fæces.

GREAT DIVISIONS OF THE COLON.

The great diviſions of the colon (which I conceive it neceſſary to enumerate, chiefly with a view to the accurate deſcription of the ſeat of diſeaſe) are theſe: Firſt, the RIGHT DIVISION of the COLON riſes from the inſertion of the ileon, and from that part of the great inteſtine which is tied down by the peritoneum and cellular membrane, and aſcends on the right ſide of the ſmall inteſtines, until it gets under the margin of the liver, and in contact with the gall-bladder. Of courſe this part will be found to take ſome conſiderable varieties in its form, depending upon its ſtate of diſtention.

THE TRANSVERSE COLON †,

The tranſverſe colon is that part of the great inteſtine which often takes a courſe directly acroſs the belly, but which generally forms an arch before or immediately under the ſtomach. When this part of the colon however is much diſtended, being at the ſame time held down by the meſocolon, its angular turns reach under the umbilicus, nay even to the pelvis. For the varieties in the ſituation of this inteſtine and the viſcera in general, ſee Morgagni Adverſar. Annat. ii. Animadver. ii.

The LEFT OR DESCENDING COLON is ſhort: for between the place where the colon begins to bend down on the left ſide, and thoſe violent turns which it takes before terminating in the rectum, is but a ſhort ſpace. It is here attached to the diaphragm and pſoas muſcle.

* Morgagni. M. Laur. Bonazzoli in the Acad. of Bologna.
† COLON TRANSVERSUM. ZONA COLI.

The

The SIGMOID FLEXURE of the colon * is formed by a narrowing and contraction, and closer adhesion of the gut to the loins below the left kidney, and to the cup of the ilium by the peritoneum, which seems to have the effect of throwing it into some sudden convolutions. The colon then terminates in the rectum.

PECULIARITIES IN THE COLON DISTINGUISHING IT FROM THE SMALL INTESTINES.

The coats of the great intestines are the same in number and in structure with those of the small intestines; but they are thinner and more difficult to be separated by dissection. The villi of the inner coat are smaller; indeed betwixt the villous coat of the ileon and the cœcum there is a distinction abruptly marked †; the mucous glands or folicules are sometimes very distinct; and, lastly, the muscular fibres have some peculiarities in their arrangement. The most characteristic distinction in the general appearance of the great and small intestines, is the notched and cellular appearance of the former. The cells of the colon being formed betwixt the ligamentous-like stripes which run in the length of the gut, have a regular threefold order. These cells give lodgment to the fæces; retain the matter; and prevent its rapid descent or motion to the rectum. Here the fluids are still more exhausted, and the fæces take often the form of these cells. When the great intestines are torpid, and inert in their motions, the fæces remain too long in the cells of the colon, and become hard balls or scibulæ. But when in this state of costiveness the intestines are excited by medicine, not only is the peristaltic motion of the intestines increased, but the vessels pour out their secretions, loosening and dissolving the scibulæ ‡.

* From its resembling the Roman S.

† Vide *Albin. Annot. Acad.* l. vi. c. viii. de intestinis et tab. ii, f. vii.

‡ See note of the pores of the intestines.

MUSCULAR COAT.

The ligamentous-like bands of the colon form three faſciculi running in the length of the gut: one of theſe, obſcured by the adheſion of the omentum, is not ſeen without diſſection; and the other is concealed by the meſocolon *. Theſe bands are formed by the longitudinal fibres of the gut, being concentrated into faſciculi, and not uniformly ſpread over the general ſurface, as in the ſmall inteſtines: and being at the ſame time more firmly connected with the peritoneal coat, they give the appearance outwardly of ligament more than of muſcular fibres †. The inner or circular muſcular fibres of the great inteſtines are like thoſe of the ſmall inteſtines, uniformly ſpread over their ſurface, and are ſtronger than thoſe of the latter.

Fæces. That the food digeſted, in part abſorbed, and its fluids exhauſted, becomes fæces in its progreſs through the inteſtines, will be univerſally allowed; but how much of the excrementitious matter in the colon is a ſecretion is not equally attended to. Men who have died of want, and men exhauſted by long fever or other diſtreſs, and who did not or were incapable of taking nouriſhment, have had diſcharges of fæces; and fæces are found in their inteſtines upon diſſection. The fœtus has the inteſtines filled with meconium ‡. The effect of a purge is not only to ſtimulate the inteſtines to throw off their contents, but the inner ſecreting ſurfaces pour out their fluids. The ſurface of the inteſtines is not only calculated to abſorb nouriſhment, and capable of throwing off the fluids from the ſyſtem, like the kidneys in ſecreting the urine, but it ſeems deſtined in a particular manner to carry off the earthy parts of the body, which in the circle of actions is re-abſorbed after conſtituting the ſolids of the body. Thus the fæces conſiſt

* Stratum liberum, ſtratum omentale & tertium Meſocolicum. Soemmer. § ccxxx.

† See Morgagni. See alſo Galeati on the fleſhy coat of the ſtomach and inteſtines, in the Memoirs of the Acad. of Bologna.

‡ See Haller Phiſ. Elem. tom. vii. ſect. 6. § 3.

of

of the food and chyme, which has not been converted into chyle and abſorbed, but which has been decompoſed, and has entered into new combinations; it is united to part of the bile, which has alſo been decompoſed; to the ſecretion of the pancreas; to the ſecretion of the immenſe extent of ſurface of the inteſtines; and many ſubſtances are found in the excrements which did not exiſt in the food. From the ſame ſources (viz. the ſecretions poured into the inteſtinal canal, or directly from its ſurface) are formed concretions, often of an enormous ſize; often diſtinct from the nature of the more common biliary ſecretions *; and ſometimes theſe earthy depoſits entering into the compoſition of the fæces, give to them a ſtoney hardneſs. In the proceſs of forming fæces in the great inteſtines, there may be changes amounting to diſeaſe; but I am rather inclined to attribute the diſeaſed changes apparent in the fæces, to the previous error of ſecretion in the higher parts of the canal, not to the diſturbed function of the great inteſtines.

RECTUM.

The RECTUM † forms the laſt diviſion of the great inteſtines; and I know no better proof of the impracticability of altering the names in anatomy than this, that anatomiſts have, in almoſt every age, inſiſted on the impropriety of calling this gut, which anſwers in its ſhape to the curve of the ſacrum, a ſtraight gut; and yet always, and to the preſent day, it is rectum.

From the laſt turns of the colon, called ſigmoid, the gut is continued over the promontory of the laſt vertebra and ſacrum (a little to the left ſide), and falls into the pelvis. It runs down, in a curved direction, betwixt the ſacrum and bladder of urine. In the upper part it is covered by the peritoneum, and has its fatty

* Haller loc. cit.

† The name *rectum* is taken from the old anatomiſts who deſcibed from brutes. A Profeſſor of Edinburgh calls it *curvum*, but this I cannot admit after reading *Morgagni Epiſt. Anat.* xiv.

 appen-

appendages like the colon, but lefs regular; and fometimes the fat merely depofited under the peritoneal coat. It is tied down by the peritoneum, in form of mefo-rectum; but, deeper in the pelvis, it lofes the peritoneum (which, as we have faid, is reflected up upon the back of the bladder, and forms here lateral folds), and the rectum is connected with the lower part of the bladder and veficulæ feminalis by celullar membrane. In women, the mufcular fibres of the rectum and vagina are intimately connected *.

The mufcular coat of the rectum is particularly ftrong. The flefhy bands of the colon, fpreading out, are continued down upon the rectum in an uniform fheath of external longitudinal fibres. The circular fibres of this part of the gut are alfo particularly ftrong; and towards the extremity, appearing in ftill ftronger fafciculi, they obtain the name of fphincter, of which three are enumerated: and this, to diftinguifh it from the others, is called the inteftinal or orbicular fphincter.

The internal coat of the rectum does not deferve the name of villous, nor of papillaris. Its furface is fmooth, and there are often diftinctly feen little foramina like the mouths of ducts or folicules, in part the fource of the mucous difcharge, which is fometimes poured out from this gut. Towards the anus the folds become longitudinal, and terminates in the notched-like irregularities of the margin†.

* Winflow.

† The prefence of ftricture within the anus feems to have given rife to converfation about a valve here. Morgagni Adverfar. An. iii. Animad. vi.

CHAP. III.

OF THE SOLID OR GLANDULAR VISCERA OF THE ABDOMEN.

SECTION I.

OF THE LIVER.

OF ITS SEAT, AND CONNECTIONS BY LIGAMENTS, AND OF THE DIVISIONS APPARENT ON ITS SURFACE.

OUR attention is now naturally drawn to the liver, as it holds, in ſo eminent a degree, the ſovereignty over the motions of the inteſtinal canal, and as it is ſo ſtrictly connected with it by its ſyſtem of veſſels, and by its functions. The liver is the largeſt viſcus in the body, and as in its ſize and proportion to the whole body it is great, ſo are its connections in other reſpects with the whole ſyſtem very intimate. This is particularly evident in the diſeaſes of the liver, and was the cauſe of the ancients aſcribing to it ſo eminent a place in the œconomy.

FUNCTION OF THE LIVER. —In all ages authors have paid particular attention to the liver, and have exerciſed their ingenuity in giving various explanations of its function. The ancients made it the ſupreme director of the animal ſyſtem. They ſuppoſed that they could trace the nutritious fluids of the inteſtines through the meſeraic veins into the porta and into the liver, and that it was there concocted into blood. From the liver to the right ſide of the heart they found the cava hepatica, carrying this blood formed in the liver to the centre of the ſyſtem: and through the veins they ſuppoſed the blood to be carried to the remote part of the body.

The liver is the largeſt glandular body of the whole ſyſtem. Its uſe is to ſecrete the bile, which is carried into

into the inteſtines, and performs there an eſſential action on the food while paſſing in the tract of the inteſtines.

SEAT OF THE LIVER.—The liver is ſeated in the upper part of the abdomen, under the margin of the ribs, and towards the right ſide, or in the right hypochondrium. In the fœtus it occupies more of the left ſide than it does in the adult. Indeed it is nearly equally balanced in the fœtus, but the older the animal (or at leaſt for the five firſt years) the greater will be the proportion of it found lodged in the right ſide.

Without going into the more minute ſubdiviſions of this viſcus, we may obſerve, that it is more uniform and ſmooth, and convex on the upper ſurface; on the lower, more irregularly concave. Its upper ſurface is applied in cloſe contact to the concavity of the diaphragm, and in the fœtus its margin is in contact with the abdominal muſcles, becauſe it falls lower than the margin of the ribs. Its lower and concave ſurface receives the convexity of the ſtomach, duodenum, and colon. In a healthy adult ſubject the liver does not extend from under the margin of the ribs, unleſs near the pit of the ſtomach, but in the fœtus and child it is much otherwiſe. In a fœtus of the third and fourth month the liver almoſt fills the belly; it reaches to the navel, covers the ſtomach, and is in contact with the ſpleen. After the ſeventh month other parts grow with a greater rapidity in proportion. Indeed ſome have affirmed, that the liver, or at leaſt the left lobe, actually decreaſes towards the time of birth *. But from this time to the advance to manhood the cheſt becomes deeper; the ſternum is prolonged; and the diaphragm becomes more concave; ſo that the liver retires under the margin of the ribs, and its margin on the left ſide in the adult reaches no farther than to the œſophagus. When however the liver becomes ſchirrous and enlarged, its hard margin comes down ſo as to be felt through the abdominal pariës under the border of the cheſt. This enlargement of the liver, and conſequent deſcent of its

* M. Portal, Acad. de Sciences, 1773.

margin,

margin, is to be felt more eaſily by graſping the integuments of the belly, as if you expected to lift up the acute edge of the liver, than by preſſing with the point of the finger. By this means we ſhall be ſenſible of the elaſticity and ſoftneſs below the liver, and of the reſiſtance and firmneſs of the margin of it. The phyſician, however, ſhould not forget, that the depreſſion of the diaphragm, and conſequent protruſion of the liver by diſeaſe in the thorax, gives the feeling of an enlargement and hardening of the liver. The left great diviſion of the liver is perhaps as often diſeaſed and enlarged as the right, in which caſe it is more difficult to aſcertain it by examination, and it muſt be learnt from other circumſtances beſides the actual touch.

Neither ſhould a phyſician be ignorant, that by ſuppuration in the lungs, and conſequent riſing of the diaphragm, the liver is elevated conſiderably, ſo as to retire farther under the protection of the falſe ribs *.

M. Portal, by running ſtilettos into the belly of the ſubject as it lay upon the table, or was raiſed into the perpendicular poſture, found that in the latter poſture the liver ſhifted two inches. But it is almoſt ſuperfluous to remark concerning theſe experiments, that they are by no means concluſive. In the dead body, the abdominal muſcles are relaxed; they yield to the weight of the viſcera: and the diaphragm is pulled down by the weight of the abdominal viſcera. The margin of the liver neceſſarily falls lower, but in the living body there is a cloſe and perfect bracing of every part by the abdominal muſcles; they do not yield, and very little if any alteration can take place in the ſituation of the viſcera,

It muſt be obſerved, however, that a conſiderable motion of the liver is the effect of reſpiration, and of the action of the diaphragm. This motion is chiefly on the back part of the right lobe of the liver. The left lobe being more on the centre of the belly, and conſequently oppoſite to the centre and leſs moveable part of the diaphragm, it is leſs affected by the reſpiration than the larger right lobe.

* Theſe obſervations in detail belong to another place.

LIGAMENTS OF THE LIVER.

The peritoneum is reflected in fuch a manner from the neighbouring parts upon the liver as to form membranes receiving the name of ligaments. It has been explained, however, that thefe are not the fole fupport of this vifcus; and that the compreffion of the furrounding abdominal mufcles is the principal fupport of the liver, as it is of the other vifcera.

The BROAD LIGAMENT * of the liver is formed by two lamina of the peritoneum, connected by their cellular membrane, defcending from the middle of the diaphragm and point of the fternum to the convex upper furface or dorfum † of the liver. This ligament is broadeft where it paffes down from the point of the fternum to the foffa umbilicalis; but as it retreats backward it becomes narrower, and is united to the coronary ligament near the paffage of the vena cava. This circumftance, with the curve which it naturally takes on the furface of the liver, gives it the fhape of the falx, as it is formed by the dura mater.

LIGAMENTUM TERES. The round ligament of the liver is the firmer ligamentous-like cord, which may be traced from the umbilicus along the peritoneum into the duplication of the broad ligament, and into the foffa umbilicalis. It is formed by the degenerated coats of the great vein which brings the florid blood from the placenta into the veins of the liver, and from thence conveys it into the right fide of the heart of the fœtus ‡.

THE CORONARY ligament of the liver is formed in confequence of the attachment of the liver to the diaphragm. The attachment is of courfe furrounded by the inflection of the peritoneum from the diaphragm to the liver. It is called the coronary ligament, though it has been obferved, that this attachment of the liver is not circular, but of an oval and very oblong fhape. It

* Ligamentum latum fufpenforium, falciforme.
† See Plate I. of this volume.
‡ See vol. ii. p. 171. and plate, p. 173.

appears,

appears, that it is this close adhesion of the liver to the diaphragm which is the occasion of the sympathy of the diaphragm in disease of the liver, and the cause of the pain felt in the shoulder and neck from inflammation, and suppuration in the liver, in consequence of the course and connections of the phrenic nerve.

The LATERAL LIGAMENTS are formed by the peritoneum continued laterally. The right lateral ligament, like a mesentry, attaches the right and great lobe of the liver to the diaphragm, and the left lateral ligament connects the left lobe with the diaphragm, and with the œsophagus and spleen.

FORM AND DIVISIONS OF THE LIVER.

The liver is convex and smooth on the upper surface; concave and more irregular on the lower part; thick and massy behind and towards the right side; but anteriorly and toward the left side it is thin, and has an acute edge, so that it lies smooth over the distended stomach.

GREAT RIGHT AND LEFT LOBES OF THE LIVER. — The first great division of the liver is marked on the convex surface by the broad ligament; which running back from the fossa umbilicalis divides it into the two great lobes, the right and left. When the concave surface of the liver is turned up, we see the same division into the right and left lobes by a fissure which runs backwards.

It is on this lower surface of the liver that we have to mark the greater variety of divisions in this viscus. Farther, it is on the right lobe that those eminences are to be observed, which, with the indentations and sulci, gives some intricacy to this subject.

LOBULUS SPIGELII *.—The lobulus spigelii is betwixt the two greater lobes, but rather belonging to the right great lobe. From its situation deep behind, and from its having a particular papilla-like projection, it is called

* *Lobulus posterior—posticus—papellatus.*

lobulus posterior, or papillatus. To the left side it has the fissure for the lodgment of the ductus venosus; on the right, the fissure for the vena cava; and above, it has the great transverse fissure of the liver for the lodgment of the cylinder of the porta: obliquely to the right, and upwards, it has a connection with the lower concave surface of the great lobe by the processus caudatus, which Winslow calls one of the roots of the lobulus spigelii. It is received into the bosom of the lesser curve of the stomach.

Lobulus caudatus*. — This really deserves the name of processus caudatus, for it is like a process of the liver, stretching downward from the middle of the great right lobe to the lobulus spigelii. It is behind the gall-bladder, and betwixt the fossa venæ portarum and the fissure for the lodgment of the vena cava.

Lobulus anonymus † is the anterior point of the great right lobe of the liver: or others define it to be that space of the great lobe betwixt the fossa for the umbilical vein and the gall-bladder, and extending forward from the fossa for the lodgment of the porta, to the anterior margin of the liver.

Sulci, and depressions of the liver. — On the lower surface of the right lobe there may be observed two slight excavations, formed as it were by the pressure of the colon and of the kidney. On the lower surface of the left lobe there may also be observed depressions answering to the convexities of the stomach and colon. But these are only the slighter irregularities which might pass unnoticed. There are, besides these, deep divisions which pass betwixt the lobes and lobuli, and indeed form these eminences.

Umbilical fissure ‡.—From the anterior point of the two lobes there passes backwards to the left side of the lobulus spigelii a deep fissure, which in the fœtus gives lodgment to the umbilical vein, and which in the

* Processus caudatus.

† Lobulus accessorius—anterior—quadratus.

‡ Horizontal fissure, fossa longitudinalis, longa, anterior.

 adult

adult receives the round ligament, where it is about to terminate in the left divifion of the vena portæ. The back part of this fiffure gives lodgment to the ductus venofus in the fœtus. This fiffure divides the liver into its two right and left divifions, and upon the right fide joins the tranfverfe fiffure.

THE TRANSVERSE FISSURE is that which paffes above the lobulus fpigelii and lobulus quadratus; the proceffus caudatus, and the lobulus lobi finiftri. It is in this fiffure that the great tranfverfe divifion of the vena portæ lies.

THE POSTERIOR FISSURE * gives lodgment to the ductus venofus. It is a divifion in the pofterior margin of the liver betwixt the left lobe, andth e lobulus Spigelii, and great lobe on the right. Sometimes, inftead of the fiffure or fulcus, there is a canal, as it were, in the fubftance of the liver.

The fourth great fiffure, is that for the lodgment of the vena cava. It fometimes is called, in contradiftinction to the laft, the right fiffure, or the FISSURA VENÆ CAVÆ. It is a large deep divifion betwixt the lobulus fpigelii and the back part of the right lobe, for receiving the vena cava as it paffes up upon the fpine.

The gall-bladder being funk in the fubftance of the liver, the pit or excavation which receives it has been confidered improperly as a fiffure or foffa †. There likeways occur irregular fiffures in the fubftance of the liver, which are like the cuts of the knife, and hold no regular place.

OF THE VESSELS OF THE LIVER, AND OF THE CIRCULATION OF THE BLOOD THROUGH IT.

There belong to the liver five diftinct fyftems of veffels: thefe are, the vena portæ; the arteria hepatica; the vena cava hepaticæ; the lymphatics; and the biliary ducts.

* Or fulcus ductus venofi, the left fiffure.

† It is generally called, *fovea fellis*, or *vallicula veficulæ felleæ*.

ducts*. These, with the nerves, form a very intricate system of vessels, but a lesson of the most particular importance to the physician. Before speaking of the connections which these vessels constitute with particular parts, or with the entire system, we shall take a strictly anatomical view of their origin and course.

THE VENA PORTÆ.

This vein is divided into two parts; that which belongs to the intestines, and which, ramifying on the mesentry, receives the blood of the mesenteric arteries; and that part which branches in the liver, and distributes there the blood which it has received from the arteries of the membranous viscera. Even from this division we see that the vena portæ has a very particular distribution; that while it is collecting its branches from the spleen, stomach, and intestines, like the veins in the other parts of the body, into a trunk, this trunk, instead of leading directly to the heart, or uniting with other veins in their course to the heart, enters the liver, and, like an artery, spreads into minute ramifications; hence it is called the vena arteriosa. It resembles an artery in this also, that it has no valves like other veins.

To be more particular; the vena portæ takes its origin from the extreme branches of the cœliac, upper and lower mesenteric arteries. The roots of the portæ answering to these arteries are the splenic vein; the gastro-epiploic vein which runs upon the great arch of the stomach; the mesenteric vein returning from the small intestines; and the right and middle colic veins, and internal hæmorrhoidal vein and left colic returning upon the mesocolon. These answering to the three great branches of the abdominal aorta, pass obliquely upward in three great divisions, and unite with some lesser veins, as the coronary and smaller veins of the stomach, and pancreatico-duodenalis. The trunk of the vena portæ is now

* And we might add, the arteries of the outer membrane of the liver which arise from the internal mammary, phrenic, epigastric, and even the spermatic arteries.

involved in the irregularly reticulated web of the hepatic veſſels, arteries, veins, glands, lymphatics, nerves, and biliary ducts, with their cellular membrane. It paſſes upward ſomewhat obliquely to the right; and enters the PORTA* or the ſinus betwixt the proceſſus caudatus and lobulus ſpigelii.

When the vena portæ has entered the liver, it divides into two great branches, which running directly tranſverſe, and being of large capacity, are ſometimes called the cylinder of the vena portæ. Of theſe two great branches of the vena portæ within the liver, the right is greater in diameter, but ſhorter †: it ramifies in the great right lobe of the liver. The left is longer conſiderably, and filling the tranſverſe fiſſure it is reflected up into the umbilical or horizontal fiſſure, and is given to the left lobe, to the upper and more anterior part of the right lobe, viz. lobulus anonymus, and to the lobulus ſpigelii.

The minute ramifications of the vena portæ every where pervade the ſubſtance of the liver, and inoſculate with the veins of the ſurface belonging to the peritoneal coat. The blood of the vena portæ, after ſecreting the bile, is received into the extremities of the venæ cavæ hepaticæ.

ARTERIA HEPATICA.

For the courſe of this artery from the root of the cœliac artery, to its entrance into the liver, ſee the deſcription of the arterial ſyſtem. The arteria hepatica and the venæ portæ are ſupported by the ſame ſheath, the leſſer veſſel encircling the greater, like a tendril. While they have diſtinct functions, both terminate in the ſame returning veins: that is to ſay, whether we admit that one or both open into the biliary ducts, yet they have the ſame relation to the venæ cavæ hepaticæ which the arte-

* Sometimes it has been found divided before entering the liver. It has been alſo found to divide into three branches, in which caſes, ſays Haller, two go to the left ſide.

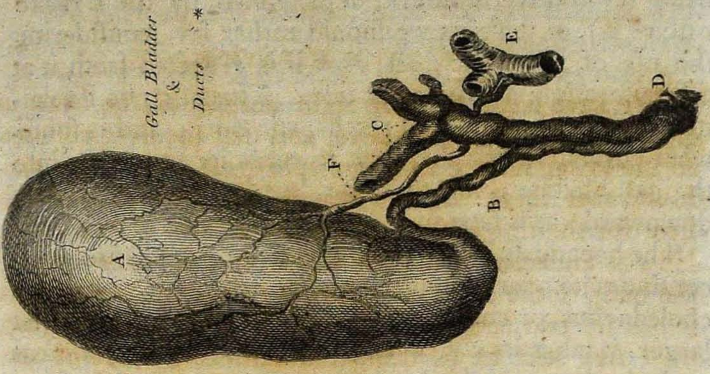
† Into this branch ſometimes the vein of the gall bladder enters.

ries of the other parts of the body have to their returning veins.

VENÆ CAVÆ HEPATICÆ.

We have ſeen, that the right auricle of the heart is cloſe to the diaphragm above, and that the liver adheres to the lower ſurface of the diaphragm. We have alſo found that there was a grove in the back part of the liver for the tranſmiſſion of the venæ cavæ abdominalis. Now as the venæ cavæ aſcending from the lower parts of the body to the heart is perforating the diaphragm, it is joined by two large veins from the liver, which, from their ſize and form, being the returning veins of the liver, are termed in general the venæ cavæ hepaticæ. Theſe veins ſometimes pierce the diaphragm together with the cava abdominalis, ſo that there is to be obſerved one large perforation in the diaphragm; but generally they paſs the diaphragm cloſe to the great vein, but ſo that there are three openings in the diaphragm. When theſe hepatic veins are traced into the ſubſtance of the liver, they are ſeen to be gathered together from all parts of the liver in two, or ſometimes three great branches. The communication betwixt the vena portæ and the venæ cavæ hepaticæ are ſo free, that ſeveral anatomiſts have imagined a peculiar and more immediate communication of their branches than holds in other parts of the body betwixt the arteries and veins; a circumſtance which appeared to them the more neceſſary, conſidering the leſſer impetus with which the blood flows in the vena portæ than in the arterial ſyſtem.

BILIARY



BILIARY DUCTS*.

The laſt ſubdiviſion of the ſubſtance of the liver, or acini, as we ſhall preſently find, is ſupplied with a branch of the venæ portæ, arteria hepatica, and venæ hepaticæ. With theſe there is alſo ſeen a minute ramification of the excretory duct of the liver. Theſe laſt minute branches are the roots of the biliary duct; which running into each other form trunks reſembling the branches of veins, and which attaching themſelves to the vena portæ form the greater trunks, anſwering to the right and left ſide of the liver. Theſe two diviſions of the hepatic duct approaching each other, unite (C), while they are attached to the right branch of the vena portæ. Their union conſtitutes the hepatic duct, or ductus choledochus.

* *Explanation of the plate of the gall-bladder.*

A The gall-bladder.
B The cyſtic duct.
C The hepatic duct.
D The common duct.
E The hepatic artery.
F The cyſtic artery coming off from it.

When

When the duct of the liver has advanced a little way from the transverse fissure, it is joined by the CYSTIC DUCT (B), or perhaps we should rather say, considering the use of the cystic duct, that it is reflected from it at an acute angle to the right side. The DUCTUS CYSTICUS is much smaller than the hepatic duct; and is somewhat curved in the direction towards its expansion into the gall-bladder; for there it takes a very sudden turn downward, as is seen in the marginal plate.

The hepatic duct, after being joined by the cystic duct, continues its course under the name of ductus communis choledochus, or common duct *. Now become somewhat larger, it takes its course under the head of the pancreas to the back part of the duodenum, about five inches from the pylorus.

Before it enters the gut, or more generally while included in the coats, it is joined by the pancreatic duct. Having pierced the muscular coat, it runs for some time in the cellular coat, in the length of the gut, and then opens upon the eminence of a considerable valvular plica of the inner coat.

This hole is regularly limited, and by no means equal to the diameter of the duct, either where it is contained within the coats of the gut, or in its course from the liver to the gut. Sometimes the hepatic and pancreatic duct open by distinct perforations.

The outer coat of these ducts is smooth and strong †; within this a cellular and nervous coat is described ‡, and muscular fibres imagined; but the inner coat is worthy of attention. It is reticulated in such a way, that a probe pushed up the duct is catched by their valve-like action §.

* Ductus choledochus, hepatico cysticus, (D).

† Although this coat resists, in a considerable degree, the distention of the duct, when blown into or injected, yet the whole are sometimes so distended as to admit the thumb. But this is rather to be considered as growth and enlargement, than distention.

‡ By Haller.

§ These I have seen mistaken for actual obstructions.

GALL-

GALL-BLADDER.

We have already noticed, that the gall-bladder is attached to the lower ſurface of the right lobe of the liver, and partly buried in its ſinus: it has ſometimes occurred that it was merely ſuſpended to the liver by a membrane like a meſentry. It is a bag of a pyriform ſhape; its greater end or fundus is contiguous to the colon; its lower end or neck to the duodenum. It has been found wanting altogether *. It is generally of a ſize to contain an ounce, or an ounce and a half of bile.

The coats of the gall-bladder are the outer peritoneal coat †; a middle cellular coat, what from its analogy to that of the inteſtines we ſhould call vaſcular coat; and an inner coat. In the intermediate coat muſcular fibres have been looked for with great eagerneſs, but none have been demonſtrated, although a conviction remains that there are muſcular fibres in the compoſition of the coats of the gall-bladder. This coat gives form, limit, and ſtrength to the gall-bladder. The third or inner coat is formed into innumerable rugæ, ſo as to take a cellular or reticulated texture. Theſe loculi, as we may call them, thus formed by the duplicature of the internal membrane, are of conſiderable variety in ſhape, ſquare, round, or triangular. Theſe rugæ, and the whole internal membrane of the gall-bladder, have a beautiful and minute net-work of veſſels upon them; and in theſe cells there can be little doubt that there are ſmall mucous folicules, or pores, or an exudation from extreme veſſels, whoſe diſcharge ſheaths the ſurface from the irritation of the acrid bile. The extreme degree of vaſcularity and

* In which caſe the dilated ducts in their courſe would ſeem to have been capable of retaining a quantity of bile ready to be evacuated into the inteſtine. A double gall-bladder has ſometimes been found.

† Like the peritoneal coat of the liver, it ſeems to poſſeſs very diſtinct veſſels from the vaſcular coat below. "Si itaque ea, a reliquis membranis ſolvitur expletis antea materia quadam colorata vaſis, ab arteria hepatica et vena portarum venientibus; videmus *eam* ne minimum quidem accipere ſurculum quo ornantur *nervea* et *vaſculoſa*." Annotationes Acad. F. Aug. Walter, p. 57.

reticulated

reticulated texture of this inner coat of the gall-bladder is not apparent before the fixth or feventh month of the fœtus, and then it takes a peculiar texture in preparation for the reception of the fecreted bile.

Towards the opening of the bladder into the cyftic duct the rugæ takes a femilunar figure, and feem to have a valvular action, in at leaft fo far that they feem intended to give a degree of difficulty to the paffage of the bile. The fame ftructure of the internal coat prevails in the cyftic duct.

However ftrange it may appear to one, confidering the relation of the liver as a gland to its ducts, and to the gall-bladder as a receptacle of the bile, an opinion was entertained that the bile of the gall-bladder was fecreted by its own coats, and that it was of a different nature from the bile conveyed from the fubftance of the liver. Without further argument it is fufficient to fay, that when the cyftic duct is tied, or when it is preternaturally obftructed, there is no bile fecreted into the gall-bladder *.

From the connections of the gall-bladder, and from the confideration of the whole anatomy, there can remain no doubt that the gall-bladder is a mere receptacle, referving a fufficient ftore of this fluid for the due change to be performed upon the food: that as the ftomach is not at all times loaded with food, nor the chyme and fluid from the ftomach inceffantly paffing through the duodenum, neither is the bile at all times running from the gall-ducts. On the contrary, as the ftomach is emptied of its contents at ftated intervals, there feems to be a provifion for a quantity of bile being evacuated from the receptacle and ducts proportioned to the food, and while it is paffing the duodenum. Whether we fhould conceive that this is a neceffary confequence of the

* Were there no other proof of the gall-bladder being only a receptacle, and not in any degree for fecreting the bile, the courfe of its veins (which run into the vena portæ) would be fufficient indication. If they had returned the blood from having performed the fecretion of the bile, they would have dropped into the cava, and not into the portæ.

retention

retention of the bile in the gall-bladder, or a wiſe proviſion of nature, I am uncertain; but it appears, that the longer the bile is retained, or the longer the faſt and the deficiency of food in the duodenum, the more acrid and inſpiſſated is the bile, and the greater alſo in quantity. This inſpiſſation of the bile takes place in conſequence of the activity of the lymphatics, which ramifying on the coats abſorb the thinner part of the bile.

Further; I cannot look upon the rugæ and cellular ſtructure of the inner coat of the gall-bladder in any other light than as the means of increaſing the ſurface, and expoſing the bile to a further abſorption of its watery parts than otherwiſe would take place.

The gall-bladder is ſuppoſed by ſome to be emptied by the general preſſure of the abdomen; an opinion founded on a miſtake, which a very little conſideration might correct. Others think that the ſtomach, or duodenum, or colon, being diſtended by the food, compreſs and empty the gall-bladder; while others with more apparent correctneſs allege, that it is emptied in conſequence of a conſent of parts. With the latter I would confidently affirm, that as the aliment paſſes the duodenum, the bile follows apace, either from the alternate contraction and relaxation of the duodenum occaſioning a relaxation of the orifice of the ducts, or more probably from the ducts being excited, as the ſalivary glands are excited by the preſence of ſapid bodies in the mouth. By want and hunger, on the contrary, the gall-bladder is allowed to diſtend: there is no call for its evacuation.

Experiments would even teach us, that the gall-bladder has not the ſame irritability excitable by ſtimuli applied to the coats, which the ſtomach, inteſtines, or bladder of urine have; which is a proof that, like the iris, and many other parts of the body, its action is rouſed more powerfully by the indirect ſtimulus and through conſent of remote parts, than by the diſtention of its coats; whereas the inteſtines and bladder have it in their conſtitution to be excited to contraction by ſimple diſtention.

From

From experiments it would appear, in confirmation of what is here alleged, that while the food is in the ſtomach little bile is diſcharged; but that it flows when the matter is paſſing the duodenum, ſo that a great quantity is then formed in the gut. On the contrary, in a ſtate of want and hunger, the gall-bladder is greatly diſtended, and yet little bile flows from it; although it is not only more accumulated, but more acrid and bitter *.

The gall-bladder is not deſtitute, however, of irritability and the power of contraction; for it would appear from many caſes that, like the urinary bladder, it contracts upon concretions, and becomes thick in its coats.

The retention of the bile, ſurcharging the ducts, and diſtending the gall-bladder, and the ſudden diſcharge of accumulated bile, and the irregularities of its courſe when influenced by diſorder of the viſcera, are the ſource of the moſt ſevere and diſtreſſing ſymptoms †.

In the dead body we ſee the colon and duodenum, or whatever parts lie in contact with the gall-bladder, ſtained with bile; but this evidence of tranſudation which is found in the dead body, is not ſeen in the living; while the ſtain from the bile is obſerved to be deeper and more extenſive in bodies long dead. It is therefore another example of the peculiar properties inherent in the living fibres, that no tranſudation is allowed ‡; but that the fluids, which appear as if exuding from

* Anat. generale de Xav. Bichat, tom. iv. p. 6.

† We have one example of this in a late Treatiſe on the Diſeaſes of the Bowels of Children, by Dr. Cheyne: an eſſay moſt particularly uſeful in its object; and the reaſoning of which is founded on anatomical obſervation, ſupported by facts, and deductions from practice.

‡ The peculiar odour of the inteſtines of a dead body is not perceptible in the living: when in diſſection the fingers touch the inteſtines, they retain the odour long; but on handling the inteſtine in the operation for herniæ, the bad ſmell does not attach, nor is it at all perceptible. Poiſon in the ſtomach of an animal will pervade the coats and affect the whole ſubſtance, if permitted to remain after death: but if the ſtomach containing the berries of the laurus cer. be taken from the pheaſant of America, they are wholeſome food.

The

from the living ſurfaces, are diſcharged from organic pores, or from the extremities of veſſels.

OF THE MINUTE STRUCTURE OF THE LIVER.

The liver is firmer and dryer in ſome degree than any of the other viſcera; the intertexture of membrane is weak, and in conſequence the ſubſtance of the liver is friable and eaſily torn. When cut or torn, it ſeems for the greater part vaſcular; or it diſplays the mouths of innumerable ducts and veſſels, and, after a minute injection, the blood-veſſels ſeem to pervade every particle, even when examined with the microſcope.

This texture of veſſels, in which we may ſay the ſubſtance of the liver chiefly conſiſts, is ſurrounded with a delicate membrane, the continued peritoneum. It retains the character of peritoneum, in being a ſimple membrane, whitiſh, and a little pellucid. In this membrane minute arteries and veins ramify, which are unconnected with the internal ſyſtem of veſſels, and in the cloſe cellular membrane beneath it the lymphatic veſſels take their courſe.

When a ſection is made of the liver, the veſſels may be thus diſtinguiſhed: the ducts by the thickneſs of their coats, and their yellow colour; the arteries by a leſs degree of thickneſs, and a more reſiſting elaſticity; the branches of the vena portæ and the cava hepaticæ by the thinneſs of their coats, of which thoſe of the latter are conſiderably the weaker.

With the inveſtiture of the peritoneal coat of the liver even the vaſcular tiſſue of the body of the liver has no

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The peccary, or Mexican hog, when killed, muſt have the dorſal gland immediately cut out, or the diſagreeable ſmell of this ſecretion makes the fleſh unfit to be eaten. For the ſame reaſon the Indians cut away the noxious glands from the Skunk immediately when killed.

For much of the anatomy of the liver, and of the bile, ſee Morgagni Adverſar. An. iii. A. xx. to xxvii.

commu-

communication by veſſels *. It is therefore conſidered as an organ of a peculiarly diſtinct organization. By the proofs from anatomical injections we are informed, that there is a free intercourſe through the extreme branches of all the five ſyſtems of veſſels in the liver. From minute injections, and the trying and making of ſections in the liver, there ſeems no likelihood of gaining information of the ſtructure and connections of theſe veſſels. Walther, who ſeems to have examined more methodically and minutely than any other anatomiſt in any age, could make no diſtinction of parts. In whatever way he made his ſections, whatever ſyſtem of veſſels he filled, whether the whole veſſels or each ſeparately, he could not aſcertain the direction and courſe of any particular veſſel, nor its inoſculations, but all was obſcure, and as if conſtituting one chaotic maſs. In wet preparations, however, he obſerved, that the extremities of the branches of the hepatic artery opened into the vena portæ: that the branches of the vena portæ had a double termination: that ſome of them, by a ſudden turn and ſerpentine courſe, terminated in the branches of the venæ cavæ hepaticæ †; while others were ſeen to terminate or open into the biliary ducts. Further he obſerved, that in all the branches of the vena portæ there was a peculiar compreſſed appearance which diſtinguiſhed them from all the other veſſels of the viſcus.

There have been obſerved, by almoſt every author, interſections of the intimate membrane of the liver, which divides and ſubdivides the faſciculi of veſſels. Theſe are, however, ſomewhat obſcure and indiſtinct. The laſt perceptible diviſions have been called ACINI ‡; and they are rather preſumed than directly proved to have in their compo-

* Soemmering. Walther, loc. cit. &c.

† I ſhould imagine that in this he might have been deceived by the leſſer branches of the portæ (filled with injection) opening into the ſide of the larger trunks; and that there is no ſuch termination of the hepatic arteries in the ſides of the vena portarum, ſo that their open mouths are diſcernable.

‡ See the definition in the introduction to the anatomy of the viſcera.

ſition

ſition an extreme ramification of the ſeveral veſſels of which the liver conſiſts *.

We have ſeen Malpighi conceiving that theſe bodies were ſimple glands collected on the ramifications of the veſſels; that they were little veſſicles; and that from them the pori bilarii took their origin. In this opinion he was ſucceſsfully oppoſed by Ruyſch, who affirmed that theſe were vaſcular; and in this he has been ſupported by Albinus. It would in truth appear, that the deſcription of theſe partitions of the ſubſtance of the liver, and the ultimate ſubdiviſion of it into theſe little grains, about which there has been ſo much ſpeculation, is not founded in an accurate obſervation, and that there are neither cryptæ, hollow or cellular, nor little bodies made up of convoluted arteries, but the minute parcels of veſſels which are obſervable; they may be called acini, according to the definition which has been given in the introduction.

Finally, Ruyſch's opinion may be given in theſe words: (Epiſt. ad Virum Clar. Ner. Boerhaave, p. 69.) "Sed nolo diutius tergiverſari, fateor ergo, quod, quando primo incipiebam me exercere in anatomicis, videbam tunc quidem, quod in jecore humano ſe oſtendebant acinuli parvi innumerabili numero, quæ tum temporis appellabantur glandulæ; nam nemo cogitabat aliter ſed manet ſola jam hæc queſtio, an acinuli hi hic herentes ſint glandulæ ſimpliciſſimæ, foliculi cavi cum emiſſario an quid aliquid? dico nemo demonſtravit illos tales eſſe ut hic aſſumis. Imo vero facile jam erit demonſtrare, acinos hos cum criptis antea pertractis nihil commune habere: quia oculis noſtris non apparent ut membranulæ cavæ & quia etiam non habent emiſſarium. Sed componuntur tantum ex extremitatibus ultimis vaſculorum ſanguiferorum unitis in formam ſpheræ rotunditatis, neque, quantum poſſum videre etiam membranula aliqua ſua ſingulari circumambiuntur."

* Acinos nemo rejicit, ne Ruyſchius quidem, ſed de interiori fabrica diſputatur. Haller.

OF THE SECRETION OF THE BILE.

Upon reviewing the whole ſyſtem of the liver the peculiarities in the vena portæ ſtrike us the moſt. It occurs to us that this great ſupply of blood to the liver, with the ſlow motion peculiar to venous blood, after having gone the circulation through the inteſtines, is a proviſion for the ſecretion of the bile. It is almoſt univerſally concluded, that the ſecretion of bile is made from the blood of the vena portæ.

But as we ſee that this blood diſtributed by the branches of the vena portæ in the liver muſt be ſo far exhauſted as to become incapable of all the uſes accompliſhed by the arterial blood in other glands, that although the vena portæ be peculiarly adapted to ſecrete the bile, it is not capable of ſupplying the nutrition and the energy to the ſubſtance and veſſels of the liver, there is a neceſſity for arterial blood being ſent to this gland through a branch of the arterial ſyſtem. We have had occaſion to remark, that no part retains its function in vigour, nor the living properties which are inherent in it, while the whole œconomy is entire and correct, unleſs the blood be circulated through it. Therefore it would appear neceſſary that the arteria hepatica, a branch of the aortic ſyſtem, ſhould alſo be beſtowed upon this viſcus. Theſe arteries perform the ſame office here in the liver that the bronchial arteries do in the lungs, or the coronary arteries in the heart, or the vaſa vaſorum in the great veſſels. The pulmonic artery carries venous blood into the lungs, which having returned from the circulation of the body cannot ſend off ſmaller branches to ſupply the membranes and veſſels of the lungs, it is neceſſary that for this purpoſe branches of the aortic ſyſtem ſhall enter the lungs. Again, in the heart the blood contained in its ventricles is incapable of ſupplying its ſubſtance; or the blood coming through the canals of the great veſſels cannot be the means of miniſtering to the active powers of their coats; but for this purpoſe the

vaſa

vaſa vaſorum are diſtributed through the coats of the veſſels. Theſe veſſels therefore bear an analogy to the arteria hepatica in the liver.

We muſt not however ſuppoſe that this ſcheme of the action of the vaſcular ſyſtem of the liver, however rational and ſimple, will be univerſally allowed. Indeed there are circumſtances which ſeem to ſtand in oppoſition to it. Of theſe, the moſt intereſting is the caſe of unuſual diſtribution of the veſſels of the liver communicated by Mr. Abernethy.

The ſubject was a female infant which was ſuppoſed to be about ten months old. Among other varieties it was obſerved, that the branch of the cœliac artery diſtributed to the liver was larger than common, and exceeded by more than one third the uſual ſize of the ſplenic artery. This was the only veſſel which ſupplied the liver with blood for the purpoſe of either nutrition or ſecretion. The vena portarum was formed in the uſual manner, but terminated in the inferior cava nearly on a line with the renal veins. The liver was of the uſual ſize, but had not the uſual inclination to the right ſide of the body: it was ſituated in the middle of the upper part of the abdomen, and nearly an equal portion of the gland extended into either hypochondrium. The gall-bladder lay collapſed in its uſual ſituation. It was of a natural ſtructure, but rather ſmaller than common. On opening it there was found in it about half a tea-ſpoonful of bile. The bile in colour reſembled that of children, being of a deep yellow brown, and taſted like bile, but it was not ſo acridly bitter and nauſeating as common bile.

Mr. Abernethy remarks upon this caſe, that when an anatomiſt contemplates the performance of biliary ſecretion by a vein, a circumſtance ſo contrary to the general œconomy of the body, he naturally concludes that bile cannot be prepared unleſs from venal blood; and he alſo infers, that the equal and undiſturbed current of blood in the veins is favourable to the ſecretion; but that the circumſtances of this caſe, in which bile was

ſecreted by an artery, prove the fallacy of this reaſoning *.

We may further obſerve on tnis caſe, that it does not prove the bile to be the natural œconomy, ſecreted by the arteries and not by the vena portæ; for the artery here was unuſually large, ſo that it performed a function in this inſtance which it does not uſually perform. On the contrary, had the artery been of the uſual ſize, we might then have concluded that the vena portæ was diſtributed to the liver to ſerve ſome leſſer uſe in the œconomy of the ſyſtem, and that it did not ſecrete the bile.

The liver, it is ſaid, was of the ordinary ſize. Now as the bulk of the liver is, in its natural ſtate, made up of the dilated veins, it is ſome proof of what I ſhould imagine had taken place here, that by ſome proviſion of the veſſels the arterial blood had been diffuſed, and the celerity of its motion checked previous to its ultimate diſtribution. Nay, it may have opened into the branches of veins anſwering to the extremities of the vena portæ.

In the deficiency of the due acrid and bitter ſtate of the bile, there is in this caſe evidence that the bile formed from the arterial blood is ſtill unfit for the perfect ſecretion. I conceive this to be countenanced by the circulation of the blood in the liver of the fœtus, and by its effects upon the ſecretion. We have ſeen in the fœtus that almoſt the entire gland is ſupplied with arterial blood returning from the umbilical vein; and the natural deduction from this is, that it is the cauſe why the bile in the fœtus is of a leſs ſtimulating quality, and ſmall in quantity.

I conclude, that this ſingular and intereſting caſe may ſtrengthen the opinion which ſome have entertained that the extreme branches of the hepatic artery pour blood into the extremities of the vena portæ previous to this formation of the bile by theſe veins; but it ſtill leaves us with the general concluſion, that the peculiarities in the

* See Mr. Abernethy's caſe, of uncommon formation of the liver. Phyſ. Tranſactions.

diſtri-

diſtribution of the vena portæ are a proviſion for the ſecretion of the bile, and that the branch of the aortic ſyſtem, the hepatic artery, is otherwiſe neceſſary to the ſupport of the function of the liver.

Finally, as to the uſe of the liver independently of the ſecretion of the bile, we muſt lay aſide the opinions mentioned by Haller, that it ſupports the diaphragm, puſhes it up in expiration, and receives the contraction of it equally in inſpiration, ſo as uniformly to compreſs the other abdominal viſcera; or that it foments and cheriſhes the ſtomach by the heat of its blood. Theſe are at leaſt as bad as the theories of the ancients mentioned in the beginning of this ſection. Haller's failing is the promiſcuous admiſſion of all facts and every kind of theory, with a timorouſneſs and indeciſion in giving his own opinion.

There is another remark of Haller which deſerves attention. When I reflect, ſays he, that there is no bile required in the fœtus, there being no food received: when again I ſee that the liver is of great ſize in the fœtus, and not ſmall like the lungs, which are deſtined to an operation in the œconomy after birth, I cannot but ſuſpect that it has ſome other uſe in the fœtus than the ſecretion of the bile. If the umbilical vein had opened directly into the cava, he thinks it would have returned with too great an impetus upon the heart, and would by its preponderancy have retarded the return of the blood from the lower extremities. He thinks that the liver is uſeful in breaking and weakening the impulſe of the blood from the umbilical vein; that it is a guard to the right auricle, which would be otherways endangered by the rapid flow of the blood. Now ſurely the liver is much leſs able to ſtand the impulſe of the blood than the heart; and yet there is no proviſion for the breaking of the force of the blood in the liver. Further, there is a direct duct of communication leading to the heart. There is no reaſon to believe that the umbilical vein carries back the blood with greater force than any other returning vein: on the contrary, from its ſize and the

 length

length of its courſe it is natural to ſuppoſe the motion of the blood in it to be very ſlow and equable.

We muſt look upon the peculiarities in the circulation of the blood in the liver of the fœtus as a proviſion againſt the ſecretion of ſtimulating bile; for when the child is born and the circulation altered, bile is formed more abundantly, and becomes the ſtimulus to the whole abdominal viſcera, rouſing them to new action. As to the compariſon which Haller has made between the ſtate of the liver and that of the lungs, it is evident that the latter, though ſmall in bulk, are fully formed, and want only inflation to complete their function. On the contrary, in the liver of the fœtus the veſſels are neceſſarily diſtended with blood, to give them the ſize requiſite for this future function; but that blood, either from its qualities or from the eaſy and direct paſſage it has into the heart, does not ſecrete the bile in quantity and quality ſo as to ſtimulate the ducts and inteſtines, as in the adult circulation. If it did, we ſhould not ſee the alimentary canal of the fœtus loaded with matter, and yet not ſtimulated to action, but in a ſtate of inactivity and torpor.

SECTION II.

OF THE PANCREAS.

The Pancreas is a gland the largeſt of thoſe which have been called conglomorated, that is, diſtinctly conſiſting of leſſer parts united. It is of a long form like a dog's tongue, and lies acroſs the ſpine, and behind the ſtomach. Its excretory duct opens into the duodenum.

The pancreas is confined betwixt the two lamina of the meſocolon, and it is united to them by a looſe cellular membrane; it lies before the great meſenteric veſſels:

ſels: its ſmall extremity touches the ſpleen, and is near the capſuli of the left kidney: but towards the right extremity it increaſes gradually in maſſineſs until its head lodges upon the duodenum. It is like the ſalivary glands in its appearance, conſiſting of lobules ſucceſſively ſmaller and ſmaller; and it alſo reſembles them in the manner in which its duct is formed. The duct * begins towards the left extremity by exceedingly ſmall branches; theſe running together form a middle duct, which taking a ſerpentine courſe towards the great extremity, and increaſed by the acceſſion of the lateral branches in its courſe, becomes nearly of the ſize of a writing quill. Now approaching the duodenum it unites to the biliary duct, and opens along with it into the duodenum. A valve has been deſcribed as in the extremity of the pancreatic duct, but it is certainly incapable of the action of a valve, as the bile has been found to have gone retrograde into the trunk of the pancreatic duct. Sometimes there are two pancreatic ducts, but more frequently the part of the gland next the duodenum, and which is called the round head of the pancreas †, has an excretory duct peculiar to itſelf, which either opens into the duodenum ſeparately from the main duct, by piercing the coats of the inteſtines nearer the ſtomach, or ſometimes opens further down.

De Graff, Ruyſch and many others have made experiments to diſcover the nature of the ſecretion from the pancreas. Tubes were introduced into the ducts, and bottles were appended to them in living dogs, ſo as to catch the pancreatic fluid: it was found ropy, inſipid, and like the ſaliva. It has therefore been concluded, from the colour, ſtructure, ducts, and ſecretion of the pancreas having ſo ſtrict a reſemblance to thoſe of the parotid and ſubmaxillary glands, that it is of the nature of the ſalivary glands of the mouth. The general opinion has been, that it is uſeful in ſecreting a fluid which dilutes and moderates the acrimony of the bile.

* Ductus Virſungi.

† This is what Winſlow calls the little pancreas, and is ſometimes ſchirrous ſo as to compreſs the biliary ducts.

More accurate chemical examination of the pancreatic fluid has not been made, or has not been fuccefsful in fhowing any peculiarity in it.

Confidering the pancreas as a falivary gland, how, great muft be the quantity of fluid poured out by it, if as we are entitled to do, we take the analogy of the parotid fubmaxillary and fublingual glands. Thefe falivary glands, although they may be faid to furround all the jaws from the zigomatic procefs on either fide, are nothing in maffinefs and fize to the pancreas, Again, the pancreas is moft plentifully fupplied with blood-veffels. Befides leffer branches of arteries, the pancreatico-duodenalis gives two branches, which take an extenfive courfe through it, and are joined by other mefenteric twigs; and twigs proceed from the veffels of the ftomach, and even from the hepatic artery; but more particularly we have to obferve the large branches beftowed upon it by the fplenic artery, where it takes its courfe clofe upon it.

While the mafticators are working, the parotid gland pours out fo great a quantity of faliva, fays M. Helvetius, that it is inconceivable, and what I fhould not believe, had I not feen it in a foldier of the guards. A cut with a fabre in the cheek had opened the falivary duct: the wound healing on the infide of the cheek left a fiftulous difcharge from the parotid duct. When he eat, there flowed from this hole a great abundance of faliva; fo that during dinner, which is not long in the Hotel Dieu, it moiftened feveral napkins. How much muft flow from all the falivary glands? How much from the pancreas, which is greater than them all collectively?

Like the biliary fecretion it is probable that the contents of the ftomach paffing the duodenum, or the bile flowing from the biliary ducts, form the ftimulus to the difcharge of the pancreatic fluid; and as we fee that the morfel in the mouth will quickly produce an almoft inftantaneous fecretion and difcharge of faliva, fo we are led to conclude that the flow of pancreatic fluid may be as fuddenly produced without the neceffity of a refervoir, as in the biliary fyftem. We naturally conceive that the effect

of

of this fluid is to diminiſh the viſcidity of the bile, and by diluting it to mix it uniformly with the food. There are however few facts to enable us to reaſon on the effects of the pancreatic fluid. If we give full credit to the experiments of Malpighi and Brunner we may conclude, that when the pancreas is taken away, the more acrid bile cauſes vomiting or voracious appetite by its ſtimulus. Schirrus of the pancreas has been found attended with a coſtive and ſlow motion of the inteſtines; which ſeems to contradict the reſult of theſe experiments on animals; but by the ſchirroſity and enlargement of the pancreas the biliary ducts may have been more or leſs compreſſed, and the retarding of the uſual quantity of the biliary ſecretion might produce the ſlowneſs of the bowels *.

SECTION III.

OF THE SPLEEN.

The ſpleen is a viſcus of an irregular, oval figure, and dark purple colour. It is attached to the great extremity of the ſtomach. It is ſoft in its ſubſtance; and

* According to the hypotheſis of Silvius, the uſe of the pancreas was to ſupply an acid ſpirit or juice, and the biliary ſecretion being of the nature of an alkali, theſe two ſtruggling together cauſed the ſeparation of the chyle from the fæces. The ſtruggle did not ſtop here, but theſe enemies being carried into the blood continued their warfare in the heart itſelf, and lighted up the vital flame there.

Nay, if we believe the experiment of F. Schuyl, (de Veteri Med.) this hypotheſis was not without its proofs; for having tied in the portion of the duodenum of a living dog, where the pancreatic and biliary ducts enter, he ſaw the ebulition from this ſtruggle of the acid and the alkali; and when he compreſſed the hepatic duct, the tumifaction of the inteſtine ſubſided; when he took off this compreſſion it was again blown up. As this experiment has not ſucceeded ſince, as Haller obſerves, Schuyl was probably deceived by the periſtaltic motion of the inteſtines.

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has the peritoneal coat very delicate. We ſhould be glad could we ſay that it is of a parenchymatous ſtructure, for in truth little is known of its organization.

In treating of this ſubject we muſt be indulged in ſome ſpeculation; and indeed it is privileged ground; for the hiſtory of the opinions regarding the ſuppoſed function of the ſpleen is full of looſe conjectures or wild hypotheſis, and nothing is as yet certainly known of its uſe.

SEAT AND CONNECTIONS.

The ſpleen is ſeated in the left hypochondrium; above the left kidney; and under the protection of the falſe ribs; and of courſe it is under the edge of the diaphragm. It is connected with the ſtomach by the cellular membrane, by the omentum, and in a ſtill more particular manner by the vaſa brevia. It has alſo connections with the left extremity of the pancreas by cellular membrane, and the branches of the ſplenic veſſels. Laſtly, it has a firmer attachment to the diaphragm, by means of a ligament formed by the peritoneum *.

The ſpleen is of no regular figure. Where it is contiguous to the diaphragm it is uniformly convex: towards the ſtomach its ſurface, while it is hollowed out and concave, preſents two ſides, ſo that we ſay the whole maſs is ſomewhat of a triangular form. The anterior edge of the ſpleen is notched with deep ſulci; behind and at the upper part the margin is large and round.

The ſubſtance of the ſpleen is the moſt ſpongy, tender, and ſoft of the abdominal viſcera; ſo much ſo that not only does the finger make an impreſſion upon its ſurface, but it actually diſorders and tears its veſſels. After a ſucceſsful injection the whole ſeems made up of veſſels; and if any thing like acini or globules are to be obſerved

* Yet the ſpleen is very apt to change its ſituation, or to fall down from under the protection of the falſe ribs. It is liable to enlargement in aſcites. From which circumſtances it will not be wonderful if it is wounded in tapping for the aſcites. See Monro on Dropſy. Lienis a ſtatu ſuo devirationes Sandifort Theſaur. Vol. iii. L. Baader obſervationes variæ. Albinus Acad. Annot. lib. vii. cap. xiv.

obſerved, the microſcope will ſhow them to be accidentally produced by the faſciculi of veſſels. It has a ſtrict reſemblance to the ſubſtance of the placenta. The ſpleen is ſeldom ſmaller than natural ; often greatly enlarged *. I have ſeen it equal to the liver in ſize, and filling the whole left ſide of the belly. It has been frequently found thus enlarged, without any peculiar ſymptoms indicating ſuch a diſeaſe during life. From its ſoft texture and great vaſcularity, like the liver, it has been found rent by blows and falls ; and wounds here, as in the liver, by opening the large veſſels are ſuddenly fatal †. Sometimes it is hard and ſchirrous, and marbled in its colour. There is ſeldom ſuppuration in it. The ſpleen has been ſuppoſed to ſwell up and enlarge when the ſtomach is empty, and to be contracted when it is full. It has been obſerved, that it is large and ſpongy in thoſe who have died a lingering death, or who have been long ailing : that on the contrary, it is ſmaller and firm in thoſe who have died ſuddenly a violent death.

We are informed, that the blood of the ſplenic vein is peculiar, inſomuch that it does not coagulate like the blood in the other veins of the body ‡.

That which more than any other circumſtance excites our attention, is the great ſize of the blood veſſels of the ſpleen. Both the ſplenic vein and the artery are of great ſize in proportion to the bulk and weight of the ſpleen ; and in their courſe they are particularly tortuous. I conceive we may alſo draw conſequences from the diſtribution of their branches to the ſtomach (viz. the vaſa brevia and left gaſtro epiploic) and to the pancreas. Its lymphatics are numerous. It is ſupplied with nerves, but has very little ſenſibility. It has no excretory duct.

Opinions regarding the use of the spleen. Of the various uſes of the ſpleen, the loweſt conjecture

* For Verities ſee Morgagni Adverſ. III. Animad. XIX.

† I have known a muſket ball ſtriking the ſpleen but not penetrating the abdomen prove fatal in conſequence of extravaſation.

‡ With regard to this point I have no opinion, having hitherto neglected to examine the fact.

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in respect to ingenuity or probability is, that like a sand-bath it foments the stomach, and promotes the process of digestion. This notion is perhaps not inferior in absurdity to that opinion which ascribed to the spleen the office of forming an acid juice, which being carried by the vasa brevia into the stomach, was supposed to excite the appetite *.

It was a better conception that the spleen is the seat of melancholy; "that moping here doth hypochondria sit:" or of "laughter holding both his sides," of which the holding of the sides was an evidence. And again, since tickling the ribs is a demonstration of the effect from this excitement of the spleen †, that the growth of the spleen promotes laughter to such a degree, that it becomes a permanent silly simper. Nay further, we have authority for the excision of the spleen from those who are otherwise incurable in their propensity to laughter!

The following is a theory which has been very commonly received. A great quantity of blood is imported into the spleen with a slow motion, owing to the serpentine course of the vessels. When the stomach is empty, the blood is received in a greater quantity by the spleen, where it has an opportunity of stagnating. Here the blood, fomented, attenuated, and in a manner dissolved by the neighbourhood of the putrid fæces in the colon, enters upon the first stage of putrefaction. By this resolving of the blood it is made more fluid, in which state it is returned by the veins, there being no excretory ducts. Now when the spleen is compressed between the distended stomach and the ribs, and the contracting diaphragm,

* I am mistaken in calling this the lowest in absurdity. The spleen has been considered as the seat of the soul! the cause of veneral appetite! the gland which formed the mucilaginous fluids of the joints! The atrabilis was received here concocted and transmitted to the liver. It drew forth and formed blood from the stomach, &c. Other physiologists, not contented with the theories presented to them, and yet incapable of suggesting others more likely, have very modestly asserted that the spleen was of no use at all.

† Risus in liene sedes videtur ex effectu titilationis nataque in plurimis mortalibus risum excitat. &c. Haller. His sober objection is, that tickling the right side will do as well as the left.

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the blood is preſſed out from it in greater quantity and celerity towards the liver, mixing with the ſluggiſh blood in the trunk of the vena portæ, repleniſhed with the fat and oil of the omentum, it dilates that veſſel, and prevents the ſtagnation and congelation of the blood. In ſhort, the ſpleen has been ſuppoſed to be ſubſervient to the function of the liver, and to the preparation of a watery (and ſub-alkaline) fluid to the blood of the portæ. Another opinion has been, that it counterbalanced the maſs of the liver ſeated to the right ſide of the belly.

Hewſon entertained a theory regarding the uſe of the ſpleen which ſullies his high character and reputation. He conceived that the ſpleen added the flat veſſicle of the globules of the blood: his only obſervation in way of proof was, that he ſaw a few red globules returning by the lymphatics of the ſpleen: the effect, I have no doubt, of the injury of its ſubſtance, or of the compreſſion of its veſſels. It ſeems to me ſtrange that ſuch a man ſeeing the large ſplenic artery throwing its full tide of perfect arterial blood into the ſpleen, full of globules, complete in every reſpect, and again ſeeing a few globules carried back by the lymphatics, ſhould imagine that this artery formed theſe few veſſicles with which it was already ſo fully charged.

Of late years we have ſeen men endeavouring to raiſe themſelves into notice by an attachment to the opinions of their departed patrons; by ſupporting thoſe opinions; by holding, as they imagine, the proofs and illuſtrations of them in their poſſeſſion: but ſeldom do we ſee the memory of great men honoured by ſuch obſequies. The officiouſneſs of Hewſon's friends in promulgating his opinions has done no honour to his memory. They have attempted to ſupport, on inſufficient grounds, what he might have had the ingenuity to render plauſible, and which are very far from adding to his reputation, imperfect as they now appear.

I conceive the ſpleen to be an organ ſubſervient to the ſtomach: and not only the conſtant attachment of it to the ſtomach in the human body, but the conſtancy with which it

it is found connected with the ſtomach in the lower animals, confirms the opinion. I regard it as a proviſion for giving the veſſels of the ſtomach an occaſional power and greater activity, enabling them to pour out a quantity of fluid proportioned to the neceſſity of the digeſtion. In the firſt place, let us examine the courſe and form of the ſplenic artery, and I think we ſhall find the great peculiarity of its ſize, and tortuous form, and ſtrong coats, a proviſion for occaſional great increaſe of power; while, if not rouſed by the peculiar ſympathies which actuate it, it is of a form to retard and weaken the velocity of the blood. This is founded on theſe propoſitions:

1. The muſcular power of an artery increaſes as it recedes from the heart; the elaſtic power diminiſhes.

2. An artery, the nearer it approaches to its final diſtribution, is the more immediately under the excitement and controul of the organ; is active when the organ is excited; is, relatively ſpeaking, quieſcent when that organ is not called by its ſympathies to exerciſe its function.

3. An artery tortuous in its courſe has more muſcularity and greater power of action than one which takes a ſtraight courſe; but in proportion to the increaſe of power which it obtains by its increaſe of length in this tortuous and bending courſe, will theſe turns retard and weaken the force of the heart upon the extreme ramifications of the veſſel.

Thus a tortuous artery is the means of increaſing the velocity of the blood by its own action, but it makes the organ leſs dependent on the general force of the circulation. We accordingly find, that in thoſe organs where there is occaſional activity alternating with a quieſcent ſtate, the artery is tortuous; and where there is an increaſe of force required in the circulation, there the artery, from being ſtraight in its courſe, becomes crooked and twiſted in every way *.

From

* This has been ſuppoſed to be the effect of the impulſe of the blood, but nothing can be more falſe. Let any one examine the artery of a limb when a great tumour is growing; the artery will be found

 tortuous,

From theſe remarks, we may be inclined to draw, from the tortuous figure of the ſplenic artery, a concluſion ſomewhat different from that which has hitherto been deduced. We may conclude that it is not the means of retarding the blood in its circulation, but of giving force to it. The ſplenic artery does not only ramify in the ſpleen, but it ſupplies all the left part of the ſtomach, and that great ſacculated extremity in particular which receives the food, and in which the proceſs of digeſtion is chiefly performed. My idea is, that when the ſtomach is empty, when there is no food in it to ſolicit the diſcharge of the gaſtric fluid, the blood circulates in a moderate degree in the coats of the ſtomach, and the ſpleen receives the ſurcharge of blood; but when a full meal is taken into the ſtomach, when the action of the gaſtric juice is required in great quantity, the action of the ſplenic artery is ſolicited to the vaſa brevia and left gaſtro-epiploic artery, and thus a ſudden flow of the gaſtric fluid is beſtowed by the increaſed activity of the ſplenic artery. When again the contents of the ſtomach are fully ſaturated with the fluids from its coats, there is no longer an excited action of the ſplenic veſſels, and the artery terminating in the veins, the ſpleen returns the blood to the liver. While the veſſels of the ſtomach partake largely of the ſupply of blood, the arteries to the pancreas alſo receive ſome increaſe of activity; and even the blood of the vena portæ requires an additional activity.

We have ſeen that the ſtomach and inteſtines, the liver, pancreas, and ſpleen are combined in function, connected by the ſame ſyſtem of veſſels, mutually ſubſervient to each other, and tending to the ſame end, the re-

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tortuous to ſupply it. Again, in the aneuriſmal varix where there is a breach in the artery, and the blood finds a freer return to the heart, the artery will be found enlarged and tortuous in order to ſupply the lower part of the limb; while there is a quantity of the blood withdrawn from the circulation by the communication with the vein.

ception,

ception, digeſtion, and firſt ſtage of the aſſimilation of nutritious matter to the ſyſtem. We leave this ſubject, refereing to the chapters on the abſorbing ſyſtem.

SECTION IV.

OF THE KIDNEY.

THE kidnies are diſtinct from thoſe parts which have hitherto engaged us, as they ſecrete the urine, and form therefore the link betwixt the viſcera of the abdomen and thoſe of the pelvis; for though lying in the abdomen, they are more ſtrictly connected with the parts in the pelvis. The ſtructure of the kidney forms a very intereſting ſubject of inquiry; becauſe it is the field of diſpute betwixt the contending parties regarding the ſtructure of glands and the theory of ſecretion. It is chiefly from the kidnies that the facts are drawn in illuſtration of the opinions of Malpighi, Ruyſch, and all the others.

FORM, SEAT, AND CONNECTIONS. The kidnies lie on each ſide of the ſpine; ſunk as it were in the fat of the loins; attached to the muſcles of the loins; and in part lying on the lower belly of the diaphragm; which laſt connection is the cauſe of the pain felt in reſpiration during inflammation in the kidney. The kidney lies betwixt the ſpine of the ilium and the loweſt rib. The right kidney is placed ſomewhat lower than the left, which is owing to the greater ſize of the liver on that ſide.

The kidnies are without the abdomen, that is to ſay, behind the peritoneum; for the kidney lying cloſe upon the muſcles of the loins, the peritoneum is merely ſtretched over it. This is the reaſon why calculi in the kidney have wrought themſelves out by fiſtulæ in the loins; and it is the ground of the hazardous propoſal of cutting into the kidney to extract calculi,

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The adipoſe membrane ſurrounds the kidney, and forms a perfect capſule; for it is this which is ſometimes in an extraordinary degree loaded with accumulated fat. Upon this capſule the cæcum is attached on the right ſide, the colon on the left, and betwixt the kidnies and the inteſtines there is a ſtrict ſympathy, which is apparent in the nephretic colic.

The figure of the kidney is that of an oval bent, or a little incurvated, ſo as to form a ſulcus or general concavity to one ſide, while the other takes a greater convexity. By the concave ſurface of the kidney, which is towards the ſpine and great veſſels, the arteries and veins and ureter paſs in by the ſinus round which the ſubſtance or glandular body of the kidney terminates abruptly.

The abdominal aorta and the vena cava lying cloſe on the ſpine and near to each other, give off laterally the emulgent arteries and veins. The renal or emulgent artery comes from the ſide of the aorta betwixt the upper and the lower meſenteric arteries: that of the left kidney has its origin a little higher than the right: and the aorta being on the left and the cava towards the right ſide of the ſpine, the left emulgent artery is ſhorter than the vein; the artery longer than the vein on the right ſide. Again, the aorta being more cloſely attached to the ſpine, the emulgent vein lies rather above the artery *.

The veſſels and eſpecially the arteries of the kidney, are very irregular in their number and form. Where they enter the body of the gland, they are accompanied with a capſule which continues with them to this final diſtribution. Sometimes a ſolitary veſſel is ſeen making its exit by the convex ſurface of the kidney.

We have had occaſion to remark on the nerves of the kidnies and their connection with the coverings of the teſticle, and to notice their effect in producing numbneſs of the thigh and retraction of the ſcrotum in inflam-

* The veſſels of the kidney vary greatly. C. H. Meuder de urinæ excretione. Sandifort Thes. viii. — Albinus. Acad. Annot. b. vii. c. 11.

 mation

mation of the gland, when ſtones lodge in the pelvis or ureter.

Upon the ſubject of the ſenſibility of the kidney, however, we muſt be aware that diſeaſe, inflammation, ſuppuration, nay even total waſting of the kidney may take place without any indication from pain.

The excretory duct of the kidney is called URETER: it leads from the kidney to the urinary bladder. When we trace it into the kidney it is found to enter the navel-like ſulcus of its concave ſide; here it is enlarged into a conſiderable ſac which is called the PELVIS of the kidney. This is a kind of reſervoir which, lying in the embrace of the ſolid and glandular part of the kidney, ſends up ſeveral elongations almoſt like the finger of a glove, which receive into them the papillæ, the concentrated uriniferous tubes. Theſe proceſſes of the pelvis are called the COLICES or INFUNDIBULI.

It may be obſerved, however, that the term pelvis is taken from the greater dilatation of the ureter within the gland, which is ſeen in brutes; and that in man it is not ſo remarkable, the ureter branching with only a leſſer degree of the ſacculated form into three or four diviſions, and theſe into the leſſer infundibuli.

The coats of the ureter are three in number; a denſe outer coat; a middle coat, apparently conſiſting of circular muſcular fibres, though this has been denied; and a ſmooth inner coat, (very improperly called villous,) which ſecretes a mucus to defend it from the acrimony of the urine. The ureters do not run in a direct courſe to the bladder of urine; they take a curving direction; are in ſome places irregularly dilated, as when they paſs over the pſoas muſcle *, dropping deep into the pelvis, and getting betwixt the rectum and bladder they open

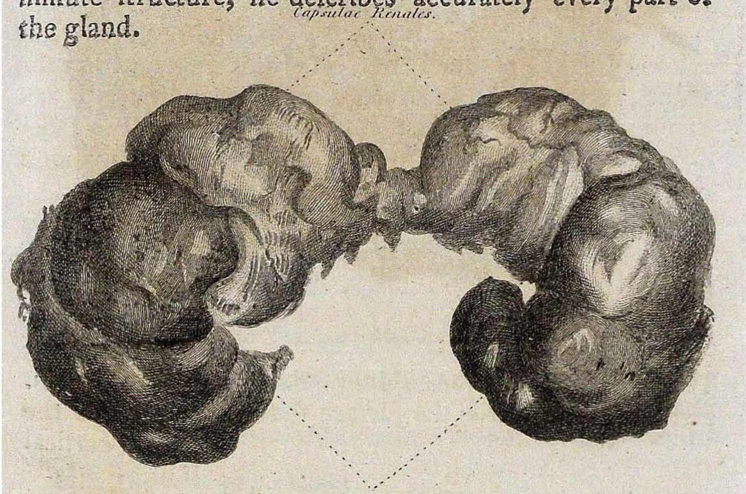
* When the bladder is contracted in conſequence of a ſtone, or when it is dilated by obſtructions the ureters are dilated alſo; particularly in the firſt caſe. Whilſt they are dilated, their coats become thickened, and their courſe is tortuous.

obliquely

obliquely into the latter. The uſe of the ureter is to conduct the urine which is inceſſantly ſecreted * in the kidney to the urinary bladder, where it can be retained and diſcharged at a convenient time.

MINUTE STRUCTURE OF THE KIDNEY.

The ancients, ſays Malpighi, contented themſelves with the idea of a ſieve, as conveying a knowledge of the manner in which the urine was drawn off by the kidney; that the fibres of its parenchymatous matter attracted the ſerum of the blood; that the fibrous matter was perforated with innumerable foramina; or that the whole was a congeries of canals through which the urine was ſtrained and drawn off. Malpighi ſet himſelf to refute theſe vague opinions by the minute examination of the ſtructure of the kidney; and he ſeems to have known almoſt all that we now know. Though we do not acquieſce in his opinions regarding the final and minute ſtructure, he deſcribes accurately every part of the gland.



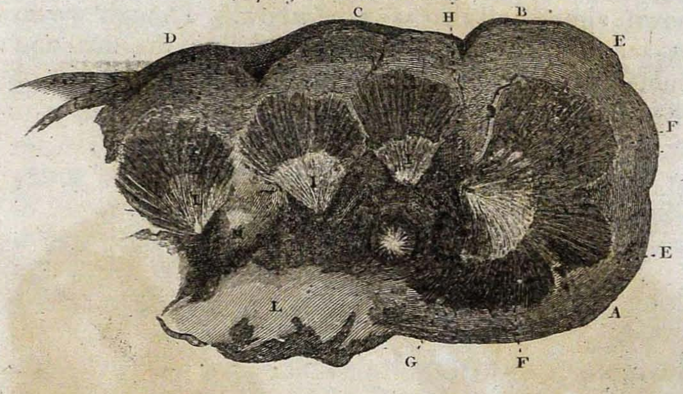
The Lobulated Kidnies of the Foetus.

* When a fiſtula of the loins communicates with the kidney the urine flows uninterruptedly.

In the first place, when we examine the outward appearance of the kidney of the fœtus, as in this annexed plate, we observe that it is not, like that of the adult, smooth and uniform; but that it is tuberculated or lobulated; that it consists of distinct parts, or glands united together. Again, when we examine the kidnies of other animals, we find in several instances that the full-grown animal retains this lobulated form. In short, it immediately strikes us that the kidney is not a uniform mass of glandular matter, but that it most resembles those glands which they call conglobate, and which consist of several compartments or distinct glands united together.

Accordingly a section of a kidney shows us that this is the fact.

Example of the Lobulated Kidney.



The * section of the kidney shows us these parts. First, we see towards the surface that which is called the cortical

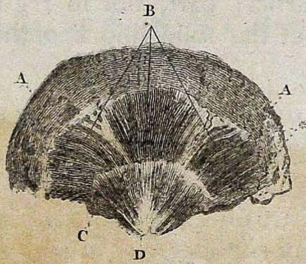
* *Explanation of the annexed plate.*

A B C D. The several divisions of the kidney which give it the lobulated figure.

E E. The cortical part of the kidney, being the outer, and, it is supposed, the secreting part.

F F. The tubular part of the kidney.

cortical or glandular part E. Secondly, ſtriæ, converging towards the centre of the kidney, being what is called the tubular part of the kidney *. Theſe tubuli are divided into faſciculi, taking a conical ſhape; and theſe converging unite at the apex; two or three of them united form the papillæ. The papillæ are generally ten or twelve in number, or even more, in each kidney; their points are received into the extremity of the infundibula; they pour the urine into theſe tubes, and it is collected in the pelvis. Now when we examine one of theſe papillæ in a lobulated kidney, we find that it is the centre of one of theſe ſubdiviſions. Thus,



A A. *Cortical Substance.* B. *Tubular part.*
C. *Papilla.* D. *Ducts.*

The papilla C is merely the continuation of the tubuli B; but it is that part which projects from the body

G. The papilla, or that part which projects into the calyx or diviſion of the pelvis.
H. The perceptible ducts in the point or apex of the papilla.
I I I. The other papilla.
L. The point of one of the papilla which we ſee projecting into the pelvis.
M. The pelvis of the kidney.
N. B. This repreſents only one half of the kidney.

* Improperly medullary, ſometimes STRIATA, SULCATA. F F. Winſlow (*traité du Baſventre*) has theſe diſtinctions of the ſubſtance of the kidney. 1. Corticale. 2. Cannellé, ſillonnèe, ou tubuleuſe. 3. Mammelonnée.

of the kidney into the calyx; and although theſe diviſions of the ſubſtance of the kidney are enumerated as three diſtinct parts, the cortical, tubular, and papillar parts, they are properly only two, the urtical and tubular parts.

Some however have made a new diſtinction, by aſſerting that a vaſcular part is to be obſerved betwixt the cortical and tubular or ſtriated parts, as at ‡, but it is not the caſe; for although when we make a regular ſection of the whole gland, the mouths of ſome larger veſſels will be obſerved betwixt the faſciculi of the urinary tubes, yet they are irregular ramifications tending to the outer cortical part, and not ſuch as ſeparate the tubular and cortical part, nor ſo regular as to be conſidered as one of the ſubdiviſions of the kidney.

OF THE CORTICAL PART.

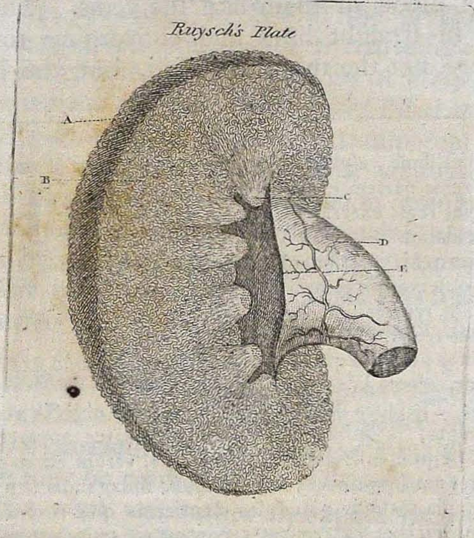
The external and cortical part of the kidney is by all allowed to be the ſecreting, or, as they rather term it, the ſecerning part of the organ. It was this part which the older writers conſidered as in a more particular manner to conſiſt of a peculiar fleſhy ſubſtance or parenchymatous matter. It is in this cortical matter that the glandular bodies deſcribed by Malpighi are ſuppoſed to be ſeated; they are called *corpora globoſa*. They are to be very diſtinctly ſeen in many brutes; for example, in the horſe's and cow's kidney; and they are to be ſeen repreſented in theſe plates. But he aſſerted theſe bodies to be alſo obſervable in the human kidney; to demonſtrate which he ejected a black liquid mixed with ſpirit of wine, by which the kidney becoming univerſally tinged, you may then ſee, he ſaid, when you have torn off the coats of the kidney, ſmall glands partaking of the colour of the arteries. Theſe are the glands of the cortical part of the kidney, which Malpighi deſcribed as hanging upon the branches of the arteries like fruit upon the pendant branches, and round which the arteries and veins ramified and convoluted, like delicate tendrils, ſo as to give them the dark colour which they have.

Into

Into these bodies he supposed the urine to be secreted, and from these bodies it was conveyed into the uriniferous ducts or tubular part of the kidney; but he acknowledges that the communication betwixt the ducts and glands is very obscure.

Ruysch and Vieussens held a very opposite opinion regarding the structure of the kidney *. Ruysch, by throwing his injections into the renal arteries, found that he filled the urinary tubes, the ducts of Belini, and the pelvis itself. Hence he conjectured that the tubuli uriniferi or excretory ducts of the kidney were the continued branches of the renal artery, without the intervention of any glandular apparatus †.

Example of Ruysch's doctrine ‡.



Ruysch

* Ruysch and Vieussens long contended for the claim of the discovery of the continuation of the arteries of the kidney into the urinary ducts. Ruysch at first acquiesced in the opinion of Malpighi, as we have said.

† Thes. Anat. ii. p. 31.

‡ Exhibet renis humani dimidiam partem ita dissectam, ut reptatus vasorum, presertim sanguineorum, loculentius quam in precedenti Thesauro, tab. iv. fig. iii. videre possit; ubi magis inherebam, ut conjunctiones arteriolarum cum ductibus Belini exhiberem, in hac autem figura

Ruyſch did not neglect the examination of the little bodies which are to be ſeen in the cortical ſubſtance. He did not however allow they were glands, but confidently aſſerted that they were merely the convoluted arteries which were formed into theſe contorted bundles before finally ſtretching out, and terminating in the ſtraight urinary tubes *.

When after minute injection of the kidney we make a ſection of its whole ſubſtance, we ſee veſſels emerging from the more confuſed intricate vaſcularity of the cortical part, and running inward in ſtriæ towards the papillæ; what we ſee there, are, in my conception, chiefly veins. And this I conclude, both from the reſult of injections, and from knowing that the veins are in general numerous ſurrounding the excretory ducts; beſides they retain the blood in them like the veins. Theſe veſſels running in ſtraight lines and converging towards the papillæ are not the tubuli uriniferi, but the blood veſ-

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figura diſtinctiſſime vaſorum ſanguineorum curſum vermicularem per interiorem renis partem exprimere volui.

A Facies renis exterior per quam vaſa ſanguinea reptatum obſervant vermicularem.

B Facies renis interior ubi vaſa ſanguinea non minus curſum vermicularem obſervant quam in facie exteriore.

C Papillæ renales.

D Pelvis renis.

E Cavitas pelvis in quam papillæ urinam ſtillando exprimunt.—See Theſaur. Anat. W. p. 27.

* In hoc Theſauro X. quoque inveniuntur objecta renalia ex homine deſumpta, in quibus non ſolum luculenter apparet quid judicandum ſit de prætenſis glandulis renalibus, verum etiam quid inveſtigatoribus renum impoſuerit, ſe in renibus indagandis ſæpiſſime occurrunt corpoſcula rotunda glandulas mentientia quæ revera nil ſunt niſi arteriolarum ultimæ extremitates contortæ; cum autem exactiſſime repleantur arteriæ renales diſſolventur vel expanduntur, quemadmodum fili glomer, ita ut nil minus ſint, ſicuti dixi, quam partes per ſe ſubſiſtentes, & peculiari membranula obductæ ſine quo immerito dicuntur glandulæ. Interim conſiderandum ejuſmodi contorſiones vaſorum ſang. nuſquam in cæteris viſceribus reperiri. In the epiſt. to Boerhaave, p. 77, we find Ruyſch ſpeaking much more modeſtly: "In rene humano rotunda corpuſcula eſſe, fateor, ſed ſunt tam exilia, ut nihil poſſimdefinire de illis. Adeoque non licet magis dicere quod ſint glandulæ, quam aliud quid."

ſels

ſels accompanying them, the tubes themſelves being tranſparent.

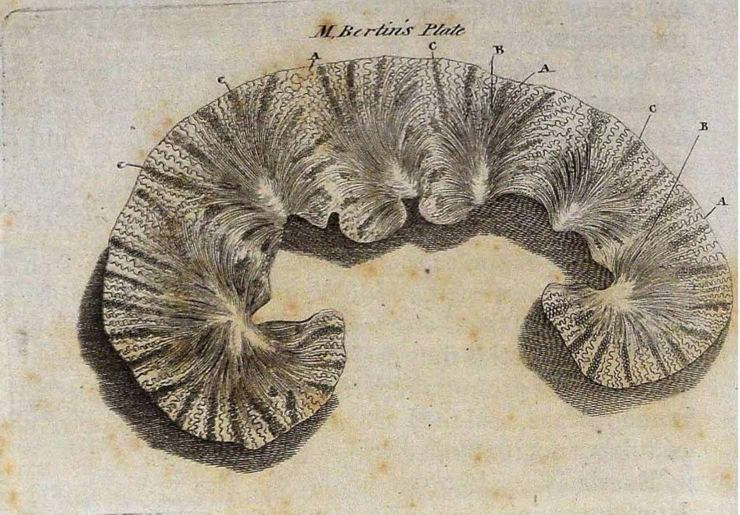
Yet I imagine it was by theſe veſſels that Ruyſch was deceived; for tracing them from the extreme arteries, and ſeeing them ſuddenly altered in their form and direction, and running towards the papillæ, he imagined them to be the excretory ducts continued from the extreme branches of the arteries.

Winſlow ſuppoſes the corpuſcules, which are ſeen in the cortical part of the kidney, to be the extremities of the cut tubuli, filled either with blood or with a coloured injection. But this they evidently are not; for by making the ſubſtance around them tranſparent, they are ſeen within the ſurface, and they are little grains, not the extremity of tubes, nor extended in lines.

Boerhaave, although he ſaw in the preparations of Ruyſch the injection paſſed into the uriniferous tubes, yet in the main favoured the opinions of Malpighi; and having ſometimes obſerved theſe tubes filled with injections, while at intervals they were tranſparent or pale, and contained only a watery fluid, he ventured to conclude that there was a double operation going forward in the kidney; that the pale watery urine was quickly drawn off by the continuous tubes; but that the urine of the other quality and higher colour was ſeparated by a more perfect and ſlower ſecretion through the glandular bodies.

In the hiſtory of opinions, to Boerhaave ſucceeds Bertin, who writes a long and laboured paper in the Memoirs of the Academy of Sciences for 1744; upon the whole, he may be conſidered as endeavouring to prove by diſſection what was rather an hypotheſis with Boerhaave. Bertin deſcribes glands in the ſubſtance of the kidney; but theſe he is careful to diſtinguiſh from the corpuſcules of Malpighi, which he alſo conceives to be the extremities of veſſels merely.

From



From this plate we ſhall eaſily underſtand Bertin's deſcription. He obſerves, in the firſt place, that there are to be ſeen ſerpentine veſſels, ſuch as Ruyſch deſcribed: for example, at A A A*, which ariſing at the circumference of the cortical ſubſtance, are reflected inward in a tortuous form, and which, at laſt, approaching the tubular part, terminate in ſtraight tubes, or are continued into the tubuli uriniferi (for example at B B).

But betwixt the meſhes of veſſels which are deſcribed, and which are ſeen here to terminate in the tubuli, there are beds of glands C C C, which acervulæ of ſmall glandular bodies are as it were laid in the tract from the circumference towards the centre, and appear to terminate or to be connected with the tubuli uriniferi as the arteries are.

M. Ferrein has oppoſed all theſe opinions in a paper of the Academy of Sciences for 1749. He aſſerts that the body of the kidney is neither compoſed of glands nor a congeries of blood veſſels; that it is a peculiar

* Meſches de M. Winſlow ou veſſeaux ſpongieux de Vieuſſens ou tuyaux ſerpentans de Ruyſch.

ſub-

fubftance, which when examined is found to confift of tranfparent veffels. Thefe, he fays, are wonderfully convoluted in the cortical part of the kidney, fo as to refemble glands, and ftretch in parallel lines towards the papillæ, where they form what is called the tubuli uriniferi. Amongft thefe tranfparent tubes the blood-veffels ramify to great minutenefs, and accompany them where they are reflected directly inward to form the tubuli. Much ridicule, he obferves, has been thrown upon the term parenchyma of the ancients; but notwithftanding he affirms that there is in all glands a fubftance diffimilar from the blood veffels, a gelatinous-like matter, which confifts of or contains thefe pellucid tubuli.

TUBULAR PART.—The term here ufed is univerfally received; and all feem agreed that the ftriæ converging to the centre of the kidney, and taking a pyramidal fhape are the excretory ducts. We have feen that they were fuppofed by fome anatomifts to be formed by the continuation of the extreme branches of the arteries; but this opinion we fhall venture to fay arofe from the appearance of the blood-veffels injected, which lie parallel and clofe to them. They are evidently tranfparent tubes, and probably the fibrous appearance of the whole pyramidal body formed by them is owing to the accompanying blood-veffels. Thefe leffer ducts, as they approach the papillæ, terminate in larger ducts, which finally open into the ducts of Belini at the point of the papillæ. The papillæ we have feen to be that part of the pyramidal body which projects into the calyx or infundibulum, and from their point little drops may be perceived to run (from the ducts of Belini) when they are compreffed.

I have detailed the feveral opinions regarding the ftructure of the kidney; and neither do I wifh here to vamp up an opinion from the aggregate of thefe contradictory reports, nor have I been able to draw a decided conclufion from my own experience. In truth, the obfervation from one diffection I have hitherto

 found

found ſo completely contradicted by other experiments, that I muſt conclude there yet remains much to be done in inveſtigating the minute ſtructure of the glandular viſcera *.

OF THE CAPSULÆ RENALES †.

The renal capſules are glandular-like bodies, one attached to each kidney. The capſule is ſeated like a cap on the upper end of the kidney. It is of a form like an irregular creſcent, and ſuited to the ſhape of that part of the kidney to which it is attached; at the ſame time that it has three acute edges, or takes a triangular form.—(See the drawing of the kidneys of the fœtus.)—The upper edge has been called criſta, while the lower edges have the name of lobes. It is in the fœtus and in childhood that the renal capſule is large and perfect; in the adult it has ſhrunk, and no longer bears the ſame relative ſize to the kidney. In the fœtus the renal capſule is as large as the kidney, and the capſules of each ſide are continued into each other, being ſtretched acroſs the aorta and vena cava ‡.

The veſſels ſent to this body are ſomewhat irregular; they come from the renal or emulgent arteries and veins, from the cæliac artery or phrenic, or from the trunk of the aorta, and even from the lumbar arteries.

By ſeparating the lobes of this body we find ſomething like a cavity, which has been roundly aſſerted by ſome to be a regular ventricle; by others altogether denied. Finding a cavity, they ſuppoſed they muſt diſcover the excretory duct. Some conceived that it muſt be connected with the pelvis of the kidney; ſome with the thoracic duct; ſome with the teſticle; but every thing relating to the uſe of this body has hitherto eluded reſearch,

* Of the kidney much in Morgagni Adverſ. Anatom. iii.

† *Glandulæ atrabilariæ, renes ſuccenturiatæ. Glandulæ renales, &c.*

‡ For various authorities on the ſize and appearance of this body, ſee Morgagni Epiſt. Anatom. xx.

and

and all is doubt and uncertain ſpeculation *. For my own part I rather conceive that this body is uſeful in the fœtus, by deriving the blood from the kidney, that gland not having its proper office of ſecreting the urine to perform in the fœtus.

* *Morgagni* Adverſar. An. iii. A. xxxii. 329. *Valſalva* is reduced to the neceſſity of quoting Scripture, and Morgagni is as much at a loſs, Epiſt. Anat. xx., being obliged to join in the words of Euſtachius: "iis relinquamus, qui anatomen accuratus exercent, inquirendum." Morgagni, loc. cit.

THE

ANATOMY

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MALE PARTS OF GENERATION.

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As there is no very accurate divifion betwixt the vifcera of the abdomen and thofe of the pelvis; as the vifcera of the pelvis, when diftended, rife into the belly, and are in every refpect like the abdominal vifcera, many have objected to a divifion of the vifcera of the abdomen and pelvis: neverthelefs, there appears to be good reafon for this divifion of the fubject. The function of the parts is different; the manner of their connection is different; their difeafes have widely different effects.

We have feen that the pelvis confifts of the facrum, os co and offa innominata, and that anatomifts have diftinguifhed the true and the falfe pelvis. The falfe pelvis is formed of the extended wings of the offa ilii, and fupports the vifcera of the abdomen. The true pelvis, marked by the cavity finking beneath the promontory of the facrum and the linea innominata, contains the rectum; the urinary bladder; the proftrate gland; the veficulæ feminales; and part of the urethra.

The manner in which thefe parts are connected, and the anatomy of the urinary bladder, proftate gland, and urethra, will form the fubject of the firft fection; while the anatomy of the parts connected with thofe of the pelvis in function, but feated without, will form the fubject of the fecond.

CHAP. III.

OF THE PARTS WITHIN THE PELVIS.

We have ſeen that the abdominal viſcera are involved in a common membrane; that this membrane is uniformly ſmooth; and that it has a ſecretion on its ſurface which bedews the whole, and allows the parts an eaſy ſhifting motion on each other. The parts in the pelvis muſt alſo have motion, but they are at the ſame time more ſtrictly connected; a looſe cellular membrane is the medium of adheſion here: the parts are imbedded in cellular membrane, which is interwoven with muſcular fibres towards the lower opening of the pelvis, and further braced by the levator ani and muſcle of the perineum. This gives to the whole due ſupport; enabling them to reſiſt the compreſſion and action of the abdominal muſcles, which they muſt receive in common with the higher viſcera of the belly.

By turning to the firſt plan in this volume we find, that the diviſion of the parts in the pelvis and abdomen is not well defined; but we ſee that the peritoneum is reflected from the pubes over the urinary bladder, and mounts again upon the rectum. The line of diviſion, therefore, is the peritoneum; while we underſtand how the bladder which belongs to the pelvis, being diſtended, carries the peritoneum before it, and riſes into the abdomen.

SECTION I.

OF THE BLADDER OF URINE.

As the general nature of the urinary bladder is ſo well known, nothing is more ſuperfluous than a general definition or deſcription. It is attached behind the os pubis; is nearly of a regular oval, when moderately diſtended,

tended, with the ends obtufe; but from its connections, and the preffure of furrounding parts, this regular extenfion is not allowed in the living body: it ftretches more laterally; its forepart is attached broad to the back part of the os pubis; and, behind, it is oppofed by the rectum. What the name would imply to be the lower part is above; for the *fundus* of the bladder is that part which, when diftended, rifes into the belly; the neck is where it terminates in the urethra behind the arch of the os pubis. On the fundus there is a ligamentous procefs, continued in a direction towards the umbilicus; this is the uracus. I would not mention it here, being a tube peculiar to the fœtus of quadrupeds, was it not to add that it is fometimes even in the adult human fubject open, fo that the urine paffes out from the umbilicus*.

When the bladder is empty, or contains only a moderate quantity of urine, it takes a triangular figure in the dead body, the bafe of which refts on the rectum, and the apex is attached to the back of the os pubis; and when in diffection you look down into the pelvis, you find the back part of the bladder flat, and as it were ftretched obliquely up upon the os pubis†.

STRUCTURE OF THE BLADDER.—Like the other hollow vifcera, the bladder confifts of feveral coats.

THE PERITONEAL COAT of the bladder does not furround the bladder, but only covers the fundus and back part. It is like in every refpect to the peritoneal coat of the abdominal vifcera; fmooth without; and adhering to the inner coat by cellular membrane; which cellular membrane is, however, of a loofer texture, and in greater

* *Fernelius de part. morb. & fymptom.* gives an example of a man who, having an obftruction at the neck of the bladder, paffed his urine by the umbilicus. Wipfer gives a fimilar cafe of a man with calculus. Thefe are quoted by *Albinus Annot. Acad.*, and alfo the Philof. Tranfactions, n. 323. See alfo Sandifort Thef. Vol. III. p. 234—46.

† This flatnefs of the bladder, and the nearnefs of the back part of it to the os pubis, the furgeon would do well to remember, before he thrufts the gorget or ftilet with fuch relentlefs impetuofity as I have feen done.

quantity than the abdominal viſcera. This peritoneal coat is no doubt of much ſervice as a diviſion in obſtructing the courſe of inflammation ariſing from the diſeaſes in the lower part of the pelvis, or from operations performed on the bladder, rectum, or peroneum; were it not for the looſe peritoneum ſpreading over the cellular texture of the pelvis, we could neither be ſo bold nor ſo ſucceſsful in our operations here. That portion of the peritoneum which covers the back part of the bladder, forms a particular tranſverſe fold when the bladder is contracted. This fold ſurrounds the poſterior half of the bladder, and its two extremities are ſtretched towards the ſide of the pelvis, ſo as to form a kind of lateral ligament.

Though in the contracted or moderately diſtended ſtate of the bladder, the peritoneum ſtretches from the back of the os pubis to the bladder, the diſtention of the bladder, in an immoderate degree raiſes the peritoneum off from the pubes, ſo that the bladder can be ſtruck with a trochar, or lithotomy performed above the pubes, by an inciſion directly into the bladder, without piercing the outer or peritoneal coat.

Towards the lower part, the bladder, as we have ſeen, is inveſted only by cellular membrane, which takes the place of the peritoneal coat of the fundus. While we are aware of the effect of the peritoneum, ſtretched over the parts in the pelvis, in obſtructing the progreſs of inflammation from the bottom of the pelvis towards the abdominal viſcera, we muſt recollect that there exiſts ſuch a ſympathy betwixt the bladder and the ſtomach and bowels, that both after operation, and in conſequence of obſtruction of urine, the patient will ſink, in conſequence of abdominal inflammation, without the direct ſpreading of the inflammatory action.

MUSCULAR COAT. — The muſcular coat of the bladder is very ſtrong. Three ſtrata of fibres are deſcribed by authors. They are ſo ſtrong as to have been claſſed with the diſtinct muſcles, and the whole coat has been called DETRUSOR URINÆ. Towards the lower part of the

the bladder the fibres are particularly ſtrong, and formed into faſciculi, and are like a net of muſcles incloſing the bladder *.

Towards the neck of the bladder the circular fibres are ſtrengthened; and embrace the beginning of the urethra; and form a ſphincter, which, no doubt, is aſſiſted in its operation by the levator ani muſcle, throwing its ſtrong fibres around the neck of the bladder. The muſcular coat of the bladder becomes greatly ſtronger, where difficulties oppoſe its diſcharge; and when there is a ſource of irritation, within the bladder, acting for any time, the whole coats become thickened, ſometimes to the depth of half an inch or more. If this thickening were entirely muſcular, the contractile power of the bladder would be deſtructive; but it is much in the other coats, and owing to a depoſitation betwixt them. This reduces the bladder to a ſtate capable but of a very inconſiderable change, either by diſtention or contraction; conſequently the urine runs frequently by painful diſcharges. The lithotomiſt would do well to diſtinguiſh when the frequent call to urine is the conſequence of a ſtone in the bladder, and when it is owing to an increaſe in thickneſs, and a rigidity of the coats of the bladder; for, in the latter caſe, the operation of the gorget is attended with very ſerious difficulties.

We have an idea of the wonderful degree of contraction in the bladder, and indeed the extent of motion in the muſcular fibre in general, when we conſider that the bladder extends ſo as to contain two pounds of urine, and contracts ſo as to force out the laſt drop from its cavity. When, however, the fibres are ſtretched too far, they loſe the power of contraction, and often the young ſurgeon is deceived by what he conceives to be an incontinence of urine while it is really an obſtruction.

I have in another place entered on the conſideration of the action of the bladder and ſphincter †. We ſhould

* Morgagni Adverſar. Anat. III. Animad. XXXIX.

† See letters on the diſeaſes of the urethra.

naturally expect what Haller found to be the case, that the bladder was more easily excited by stimulus applied to it when it was distended than when it was nearly empty *; for so it is with the will as its excitement.

VASCULAR COAT, OR CELLULAR COAT.

When I call this third coat of the bladder the vascular coat, it is merely from its analogy to that coat of the intestines which I have distinguished by the name of vascular. Anatomists have called it the nervous and cellular coat; the first of which is quite improper and the last apt to be confounded with the surrounding cellular outer coat. This coat (if coat it may be called) consists of very extensile white lamellæ of cellular membrane. It gives distribution to a few vessels, and connects the muscular fibres and inner coat.

The INTERNAL COAT of the bladder is very smooth on its general surface, and is bedewed with a sheathing mucus. When the bladder is distended, no inequalities are to be observed; but when contracted, it falls into folds and rugæ. From an acrid state of the urine; from strangury, from calculus, the mucous discharge is increased, even so as to form a great proportion of the fluid evacuated from the bladder. No visible source of this mucus is to be observed on the inner surface of this membrane †; so that probably it is a general discharge from the surface. Indeed, it appears, that no folicules or cryptæ, discharging at particular points of the surface, could have the effect of bedewing and defending the whole surface from the acrimony of the urine. The great sources of the mucus discharged with the urine, are the neck of the bladder, the prostate gland, and the urethra ‡.

* *Halleri Opera Minora*, p. 383. See further,

† Winslow, however, describes the glands, and Heister and Haller describe folicules, near the neck of the bladder, and round the insertion of the ureters.

‡ When the mucous secretion is diminished by a disease of the surface, it seems much more readily to allow the calculous concretion to form upon it.

The

The URETERS, which convey the urine from the kidneys to the bladder of urine, open very obliquely into the bladder, towards the back and loweſt part of it. The conſequence of their oblique perforation of the coats is, that, the greater the tendency of the urine to paſs retrogade in to them from the bladder, (there being a proportioned diſtention of the coats of the bladder,) the more their mouths are compreſſed, Thus, in the dead body, there is no degree of diſtention which cauſes the water to paſs by the ureters. The contraction, or rather the reſiſtance to diſtention, of the ureters and pelvis of the kidneys ſeems much greater than the powers of the bladder are able to oppoſe; for in obſtructions of urine in the urethra, there is ſtill an inceſſant accumulation in the bladder, even when the bladder has encreaſed to ſuch a ſize as to be compreſſed by the action of the abdominal muſcles. The cauſe of this yielding of the bladder to the ſecretion of the kidney is, that it has little permanent contraction, though occaſionally its action is very great.

*Corpora carnea**. —Where the ureters terminate, there are two fleſhy bodies ſtretching forward, which run together near the opening of the urethra; and at their meeting there is a prominence of the inner membrane of the bladder. From this prominence a line is continued forward, which terminates in the *caput gallinaceum*.

The URACHUS does not belong to the human bladder. It is a tube which, in the fœtus of quadrupeds, communicates betwixt the bladder of urine, and the membrane called alantoes. But in the human fœtus there is no ſuch communication; both in the fœtus, and ſomewhat leſs diſtinctly in the adult, there is a ligament like the remains of the duct which runs up between the pe-

* *Corpora Carnea Morgagni.* Vide Adverſar. Anatom. i. 9. A. iii. 421. Mammeleon allongé *Splanchnologie par R. J. C. de Garengeot.*

ritoneum and linea alba of the abdomen towards the umbilicus.

SECTION II.

OF THE PROSTATE GLAND.

On the neck of the bladder, and ſurrounding about half an inch of the beginning of the urethra, there is a gland nearly of the ſize and figure of a cheſnut. This body is called the proſtate gland. In all the extent of anatomy, there is not a more important ſubject for the attention of the ſurgeon than this of the ſize, relation and connection, and diſeaſes (with their effects) of the proſtate gland: but to enter upon theſe is not now our object.

The ſhape of this body is round, but at the ſame time ſomewhat pyramidal, for it is broad towards the bladder, and points forward. It has alſo a diviſion, forming it into two lobes; and the older anatomiſts ſpeak of it as double. The urethra paſſes through it; not in the middle, but towards its upper ſurface; ſo that the gland is felt more prominent downward, and is diſtinctly felt by the point of the finger *in ano*. This gland indeed reſts, as it were, on the rectum. By the annexed drawing *, it is meant only to give an accurate conception of theſe parts, and not to repreſent them as they are felt in the living body. For this reaſon the drawing is made from a preparation, and not from the recent diſſection. When the catheter is introduced, and the ſurgeon examines the ſtate of parts by the rectum, he will firſt diſtinguiſh the curve of the ſtaff, covered with the bulb of the urethra: behind this the catheter will feel more bare of parts, but ſtill covered with a greater thickneſs of parts

* Plates III. and IV.

than

than one ſhould expect from the deſcription of the membranous part of the urethra. And behind this, again, he will feel the prominence of the proſtate gland, not round, diſtinct and accurately defined, but gradually loſt both before and behind, among the ſurrounding cellular membrane and muſcular fibres which involve it.

The texture of the gland is a compact ſpongy ſubſtance, and when cut has conſiderable reſemblance to a ſchirrous gland. From each lobe there are ſmall folicules opening into the urethra, and from theſe the ducts may be injected *.

It has been ſaid, that there is really no diviſion of this gland into lobes: but perhaps the beſt authority on this queſtion is diſeaſe. Now it happens ſometimes that only one ſide of the gland is enlarged, which is a proof that there is ſome diviſion betwixt the lobes. This unequal ſwelling of the gland diſtorts the urethra, and gives it a direction very difficult to be followed by the catheter. In general, when equally ſwelled, the greater part of the gland, being beneath the urethra, raiſes it up ſo that the point of the catheter muſt be raiſed over the enlarged gland before we can paſs it into the bladder. This body is little liable to inflammation, and occaſional tumefaction, ſo as to obſtruct the urine; its enlargement is a chronic diſeaſe, and peculiar to advanced age.

On the lower part of the gland, and betwixt the bladder and the veſiculæ ſeminales, there is a diſtinct portion of the gland, of which Morgagni gives this account. But if any addition is to be given to the deſcription of the proſtate gland, it is that roundiſh and ſmooth body like a gland which of ten our very diligent diſſector has ſhewn in the public diſſections. It lies prominent betwixt the bladder and ſeminal capſules where they are united. Upon our moſt accurate examination, we find this to be nothing more than a part of the proſtate itſelf †. After

* As firſt done by Monro.

† Vide *Morgagni Adverſaria Anatomica, Animadverſio* XV. *Proſtate propago.*

nothing

this I can ſee no objection to calling this part of the proſtate gland LOBUS MORGAGNI. Morgagni likewiſe obſerves that it is not always to be found.

The urethra in its paſſage from the bladder is firſt carried through the proſtate gland in a courſe deſcending; when it is free of the gland, it is at the loweſt level from this point; it then paſſes forward to meet the bulb of the ſpongy body, and is then carried upward, embraced by the ſpongy body of the urethra *.

Cowper's glands are two glandular bodies ſometimes found in the angle of union of the urethra and bulb of the ſpongd body †.

CHAP. II.

OF THE PARTS CONNECTED WITH THE VISCERA OF THE PELVIS, BUT SEATED WITHOUT IT. — OF THE PENIS AND URETHRA. — OF THE TESTES.

SECTION I.

OF THE PENIS AND URETHRA.

STRUCTURE OF THE PENIS.

THE penis conſiſts of three ſpongy bodies; which, being conſtituted to receive the influx of blood, admit of diſtention, and conſequent erection. Two of theſe bodies are called the CORPORA CAVERNOSA PENIS, and

* No man ſhould venture on a deſcription of theſe parts without ttending to that of Morgagni, Animadverſio XLI.

† Firſt deſcribed by *Cowper*, or *M. Mery*. See *Garengeot*.

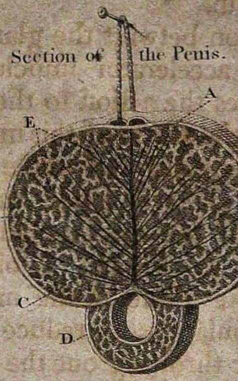
and form the body of the penis; the other is the CORPUS SPONGIOSUM URETHRÆ, a veſicular and ſpongy ſubſtance, which ſurrounds the whole length of the urethra, and expands into the bulb of the urethra in the perineum, and into the glans on the point of the penis.

CORPORA CAVERNOSA.—The body of the penis conſiſts of two tubes formed of a very ſtrong ſheath. This ſheath has a great degree of elaſticity, but at its utmoſt extenſion powerfully reſiſts the farther diſtention with blood. Theſe tubes are united in the greater part of the length of the penis, or they are parted by an imperfect partition. The root of theſe bodies, or CRURA PENIS, as they are called, ſeparate in the perineum, ſo as to take hold on the ramus of the os pubis. Foreward, theſe bodies or tubes terminate in rounded points under the glans penis.

Theſe tubes are of a ligamentary nature, only ſo far diſtinct in poſſeſſing a certain degree of elaſticity. They encloſe and ſupport the cavernous ſtructure of the penis. This ſubſtance conſiſts of cells connected with each other, and having a free communication through the whole extent of the penis. Theſe cells are interpoſed betwixt the extremities of the arteries and veins, or probably while the arteries have communication, and open into the extremities of the veins, in the common way, they have ſuch connections with the cellular ſtructure, that in the accelerated action they pour their blood into the cells; yet the blood circulates in the penis during erection as at other times.

Section

Section of the penis as inflated.



A, Corpus cavernosum Penis. B, Septum. C, Urethra. D, Corpus spongiosum Minus, or spongiosum Urethræ.

CORPUS SPONGIOSUM URETHRÆ.

Surrounding the urethra there is a spongy body similar to that which forms the body of the penis. Where this spongy sheath of the urethra lies in the perineum, betwixt the crura of the penis, it is enlarged with a round head, which is called the bulbous part;— it is upon this, and on about an inch and an half of the lower part of the spongy body, that the ejaculator seminis or accelerator urinæ acts; and, as within this enlargement of the spongy body which surrounds the urethra there is also a dilatation of the tube of the urethra itself, the use of the muscle is evident. It contracts upon this sinus of the urethra when distended with the discharge of the vesiculæ, the prostate gland, and testicle. As an accelerator urinæ, it cannot act, but it expels the last drop of urine, as a consequence of their detention in this more dilatable part of the urethra.

The spongy sheath of the urethra, as we have hinted, is enlarged into the GLANS, so that the action of the accele-

accelerator muſcle affects the whole length of the ſpongy body of the urethra and the glans by the compreſſion of the blood in the bulb.

There is a connection betwixt the glans, ſpongy tube of the urethra, and accelerator muſcle. The excitement of the glans gives the action to the accelerator or or ejaculator muſcle; the action of this muſcle compreſſes the bulb, and in conſequence the whole ſpongy body to the extremity of the glans is made turgid, and compreſſes the diameter of the urethra, adapting it to the emiſſion of ſemen. Mr. Home, I obſerve, ſuppoſes "that an action takes place in the membrane of the "urethra during copulation, to reduce the ſize of the "canal, and fit it for throwing out the ſemen with the "neceſſary velocity:" but for this opinion, there ſeems no ground nor proof; and I imagine, the action of the accelerator, and the ſtate of diſtention of the ſpongy body, will then affect.

The obtuſe point of the glans is ſpread upon the extremities of the cavernous bodies of the penis, which yet have no communication with the glans. We obſerve a circular margin, the corona glandis, and behind this the cervix. About the corona and cervix there are many little glandular bodies *, which are no doubt for preſerving the mobility of the preputium.

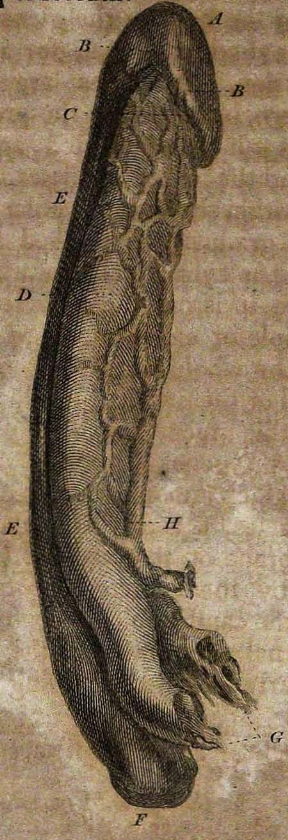
The preputium is a looſe prolongation of the integuments of the penis, which hangs over and defends the delicate and ſenſible ſurface of the glans. Its inner ſurface is of courſe the continued ſurface of the common integuments, while it again is reflected over the glans. Upon the lower ſide the preputium is tied in a particular manner to the ſurface of the glans behind the orifice of the urethra. This connection limits the motion of the preputium, and is called FRÆNUM PREPUTII.

The whole integuments of the penis are of the ſame cellular ſtructure with thoſe of the reſt of the body, and may be with equal facility inflated: they are particularly looſe and diſtenſible, and unincumbered with fat.

* Glandulæ odoriferæ of Tyſon. See Morgagni Adverſar. IV. Animad. XII. et ſequent. *de tuberculis Coronæ penis.*

A third

A third common integument of the penis is diſtinguiſhed, and is called the tunica nervoſa. It is of a more firm elaſtic ligamentary ſubſtance. A ligament, however, is not elaſtic, and the firmneſs here is merely that of a greater degree of condenſation in the common membrane. It is this membrane, which being attached to the os pubis, and ſupporting the penis, forms the ligamentum elaſticum ſuſpenſorium.



A Glans.
B B Corona Glandis.
C Cervix.
D Corpus Cavernoſum Penis.
E E Corpus Spongioſum Urethræ.
F Crura of the Penis, by which it is attached to the Ramus of the Pubes.
H Vena ipſius Penis.

OF THE URETHRA.

The urethra is all that length of the canal from the neck of the bladder to the extremity of the penis. It is formed of the continuation of the inner and third coat of the bladder, which laſt forms a reticular membrane,

uniting the inner membrane to the ſpongy body. It is, however, ſupported through all its length, near the bladder, by paſſing through the proſtate gland and ſphincter fibres; further forward than this, where it paſſes from the proſtate to the beginning of the ſpongy body of the urethra, it is inveſted and ſupported by firm cellular and ligamentous membranes; and in the length of the penis it is included in the ſpongy body, which extends form the bulb to the glans. It cannot be deſcribed as a cylindrical canal, for it admits of very unequal diſtention. It begins large at the neck of the bladder, where, immerſed in the proſtate gland, it forms a little ſinus; it is contracted again in a remarkable degree behind the bulb; it dilates into the SINUS OF THE URETHRA within the bulbous enlargement of the ſpongy body; it is gradually diminiſhed forward; and it may be conſidered as cylindrical forward to the point of the glans, where it is much contracted *, and we find frequent example of calculi detained at this place, which have paſſed the whole length of the canal.

The canal of the urethra is bedewed with mucus. The ſources of this mucus are here particularly apparent; for, beſides the general ſurface, there are large lacunæ ſeen; into which mucus is ſecreted, and from which, as from receptacles, it is preſſed as the urine flows †. The inner membrane of the urethra is very delicate, and, when torn by the catheter, or by violent chordee, or opened by the cauſtic, bleeds profuſely.

The internal membranes of the bladder and urethra are particularly ſenſible; drawing after them, when ex-

* Haller. Com. lib: xxvii. ſect. i. § xxx. Mr. Home's Strictures. Obſerv. de partibus genitalibus ſexuſpotioris Sandif. Theſ. VIII. p. 71.

† Theſe are the *Canalculi Morgagni*, Adverſ. Anat.—De glandulis urethræ vide Morgagni Adverſar. IV. An. vii. et ſequent. There is much controverſy and much confuſion regarding the gland of the uretha, viz. *Proſtatæ minores*; *glandulæ Cowperianæ*; *glandulæ Littreanæ*, &c. The reaſon of which I believe to be, that the *lacunæ* do not appear glandular unleſs when they have ſuffered by inflammation, there is no round ſmooth body attached to them, nuleſs their ſecretions have been increaſed and the cellular membrane and veſſels are condenſed around the lacunæ.

cited,

cited, not only the action of all the muscles in the lower part of the pelvis, but having sympathies in a particular manner with the testicle, stomach, and bowels, and with the whole system. The more curious and important effect of the injury of the urethra is the paroxysm of fever which it induces. Observing the regular occurrence of an intermitting fever in cases of fistula in the perineum, we should imagine it to be the effect of the extravasation of the urine in the cellular membrane, and the effect of general irritation; until it is observed that the simple stricture produces that effect, and that a touch of the caustic brings on a violent paroxysm.

When the reticular membrane is inflamed, of course it loses its elasticity, and gives pain in erection. Sometimes the inflammation, being continued to the spongy body surrounding the urethra, makes it unequal in its capacity of distention to the cavernous bodies of the penis, and sometimes their cells are united by adhesion in the worst cases of chordee.

I cannot imagine with some, that the urethra is muscular; *first*, because I see no end it could serve in the œconomy; *secondly*, because there is no proof in support of the opinion; *thirdly*, because it is surrounded with strong fibres and a spongy body, which conjointly seem calculated for every purpose of the œconomy, and likely to account for every symptom which might be mistaken for spasmodic action in the canal itself. The idea of muscularity is derived from the symptoms of stricture and irritability of the canal *.

The uretha is very elastic; not only allowing a very large bougie to be passed, and closing upon a thread, but it still more remarkably admits of elongation than of distention in the width of the canal. It is surrounded, as we have seen, with a spongy body and the cellular coat which is betwixt the delicate lining membrane of

* Morgagni describes the membrane of the urethra as double, having vessels betwixt its laminæ. These are the veins described by Dr. Barclay. Observ. Anat. P. I. tab. IV. J. C. Brims, Sand. Thes. VIII., describes two laminæ, one of which he considers to be the continuation of the muscular coat of the bladder.

 the

the urethra, and the ſpongy body partakes of the ſtructure of both, and is very elaſtic. But when an inflammation attacks the canal, this cellular membrane is its principal ſeat. The point affected loſes its elaſticity; no longer ſtretches with the penis and urethra, but conſolidates, or forms a ſtrong membranous filament. To ſuppoſe this ſtricture to have been formed bythe muſcular contraction in the diameter of the canal *, would be to allow the partial action of one or two fibres; (for the ſtricture is like that which would be produced by the tying of a pack-thread round the canal, being a narrow circular ridge;) which is very unlikely. Sometimes, however, the ſtricture is only on one ſide of the canal, which, allowing it to be formed by inflammation, is very likely to happen: but in conſequence of the muſcular action, cannot eaſily be ſuppoſed to take place, ſince the drawing of the muſcular fibres would equally affect the whole circle.

As to the effect of heat and cold on an obſtruction, it may be explained ſimply, without the ſuppoſition of muſcular contraction: for as we know that the ſpongy bodies, and of courſe the whole canal, relax andelongate in warmth, as they are ſhrunk up and contracted in cold, like the ſkin of the body in general, without implying muſcular contraction: ſo we ſee how this ſtate would affect a ſtricture;—that, when the penis and the urethra was ſhrunk, the effect of the ſtricture would be increaſed, and the patient could paſs his urine only when the parts were relaxed, by ſitting in a warm room, or by the uſe of the bath.

But when ſurgeons ſpeak of ſpaſms of the urethra, they ſeem to forget the action of the ſurrounding muſcles. Thus acrid and ſtimulating urine, or an irritable ſtate of the urethra, will be followed by a ſmall ſtream of urine: or perhaps a temporary obſtruction is the conſequence: but why ſhould we ſuppoſe that the membrane of the

* "A ſtricture," ſays Mr. Home, "whether in the ſpaſmodic or "permanent ſtate, is a contraction of the tranſverſe fibres of the mem-"brane which forms the canal."

urethra, which has no appearance of muſcularity, cauſes this effect, when it is probably produced by the ſphincter muſcle, the fibres which ſurround the membranous part of the urethra, the levator ani, and, above all, by the accelerator urinæ, a muſcular ſheath of fibres ſurrounding three or four inches of the canal. Round the membranous part of the urethra, and behind the bulb, there is much interlacing of muſcular fibres; and the levator ani, ſplitting, embraces it. Round the ſinus of the urethra and the bulb which covers it, is the accelerator urinæ, more properly the ejaculator ſeminis; and as the ejaculator ſeminis contracts upon the ſinus, it drives onward the ſemen along the urethra, ſince the ſeminal fluids do not paſs backward into the bladder, unleſs when the action of the parts is much diſordered; there muſt be a contraction round the urethra behind the bulb during the action of the ejaculator. The ſenſibility of the glans holds a controul over the action of theſe muſcles; and the diſeaſe of the bladder and of theſe parts affects the glans. There is, in ſhort, a complicated apparatus here, and we cannot wonder, that the moſt frequent ſeat of diſeaſe is juſt at the beginning of the ſinus of the urethra, where the muſcular action is ſtronger, and the canal narroweſt. At this place is the ſtricture of the urethra moſt common, and here if ſpaſm and muſcular action ſhould bring it on, if ſpaſmodic action ſhould prevail during the permanent ſtricture, or bliſtering bring on a ſtrangury, (ſeeing that this point is ſo ſurrounded with muſcular fibres deſtined to a particular action,) we muſt not take theſe ſymptoms as indicating a muſcularity in the whole tract of the urethra. I believe it is found, that ſtricture is moſt frequent juſt behind the bulb of the urethra; where I have alledged, the muſcularity is greateſt; and alſo about the diſtance from the extremity of the urethra which anſwers to the termination of the ejaculator muſcle *.

* Theſe few obſervations on ſtricture in the urethra I have left in this edition, as ſhewing the origin of the opinions more fully explained in the Letters on the Urethra.

SECT.

SECTION II.

OF THE TESTES.

THE TESTICLE might be confidered as more naturally connected with the abdominal vifcera, than with thofe of the pelvis, as its original feat is on the loins amongft the abdominal vifcera, and as it receives its coats from the peritoneum, its veffels from the abdominal veffels, and its nerves from the plexus belonging to the vital parts.

The tefticles are two glandular bodies which fecrete the femen: they are feated in the fcrotum, and are covered and protected by feveral coats; they receive their veffels from the aorta and cava, or the emulgent veffels; their excretory ducts run up into the belly, and terminate in the urethra near the neck of the bladder.

THE SCROTUM, in which the tefticles are lodged, is a continuation of the common integuments; its cellular membrane is particularly lax and free from fat, and the water of anafarca is extremely apt to fall down into it, fo as fometimes to diftend the fcrotum to a tranfparent bag of enormous fize; and not unfrequently the cellular texture here has been blown up to counterfeit rupture and other difeafes.

OF THE DARTOS. — The cellular fubftance of the fcrotum is peculiar in its appearance, being red and fibrous. It has been confidered as a mufcle, and called DARTOS *: although this is denied by many. Its action is to fupport and brace the fcrotum; and in bad health †, and in old age, it is fo much relaxed as to allow the tefticles to hang upon the cords. But befides the fimple corrugation and relaxation the fcrotum has a motion like the vermicular motion of the inteftines, from fide

* Δαρτος Veterum.

† Nurfes attend to the ftate of the fcrotum in children.

to ſide, and alternately. Its contraction has a relation to the healthy ſecretion of the gland within, and when for ſome obſtinate diſeaſe of the body of the teſticle bliſters are applied to the ſcrotum, we may ſee this muſcle in great activity rolling round the teſticles like an inteſtinal motion. The ſtraight fibres of the *cremaſter* muſcle could not I imagine perform this revolving motion, and therefore I conclude that the dartos is a muſcle on a teſtimony better than is to be had from diſſection.

There may be traced from the web of cellular membrane which covers the abdominal muſcle, a kind of imperfect expanſion deſcending upon the teſticles. This becomes very ſtrong when hernia has taken place at the ring *.

Upon the ſurface of the ſcrotum, directly in the middle, there is a line paſſing from the lower part of the penis to the anus; the RAPHA. This line marks a diviſion in the ſcrotum, not ſuperficial merely, but a partition, or ſeptum, is formed, dividing the ſcrotum into two diſtinct cellular beds for the teſticles.

COATS OF THE TESTICLE. Beſides the involving ſcrotum, each teſticle has two diſtinct coats, the tunica vaginalis and tunica albuginea. The tunica vaginalis covers the teſticle looſely; that is, without adhering to its general ſurface: but the albuginea is in cloſe union with it, and is the immediate coat of the teſticle. The

* *Mauchart* de hern. p. 14. tab. 2. *Garengeot Haller.* Monro. — I have during operation divided this into three lamina.

Over the proper coats of the teſticle the *cremaſter* muſcle is expanded. The origin of this muſcle (as we have ſeen in Vol. I.) is from the internal oblique muſcle of the abdomen. It paſſes through the hole of the external oblique muſcle called the *ring* and deſcends over the veſſels to the teſticle, conſtituting a part of the cord and finally ſpreading its fibres over the *tunica vaginalis teſtis*. Its uſe is to ſuſpend and draw up the body of the teſticle.

Under the fibres of the muſcle we may diſcover a proceſs of cellular membrane which comes down from the cellular membrane behind the peritoneum and has been uſually called a proceſs of the peritoneum even before the coats of the teſticle were diſcovered to be originally formed by that membrane.

inner

inner ſurface of the vaginal coat is perfectly ſmooth, and an exudation is poured out from it, as from the peritoneum within the belly, the outer ſurface of the tunica albuginea is alſo ſmooth and firm, and white, whence its name. But on its inner ſurface, like the peritoneum, which covers the inteſtine, and adheres to the muſcular coat, it adheres to the tubes of the teſticle itſelf. Theſe inveſting coats are in ſome reſpects diſſimilar, yet in general much alike, being continuations of the ſame membrane, and both prolongations of the peritoneum. The outer membrane, the tunica vaginalis, is a protection to the teſticle, gliding eaſily on the inner coat, and aided by the mobility of the cellular membrane of the dartos, it preſerves the teſticles from bruiſes and ſtrokes to which it would be expoſed if it were more firmly attached. The inner tunic, or albuginea, gives ſtrength and firmneſs to the ſubſtance of the teſticle. Betwixt theſe coats is the fluid collected, which forms the hydrocele. They alſo contain the congenital hernia; but the common hernia is without both coats of the teſticle. To underſtand the anatomy of this part thoroughly we muſt attend to the deſcent of the teſticle, and to the manner in which theſe coats are formed.

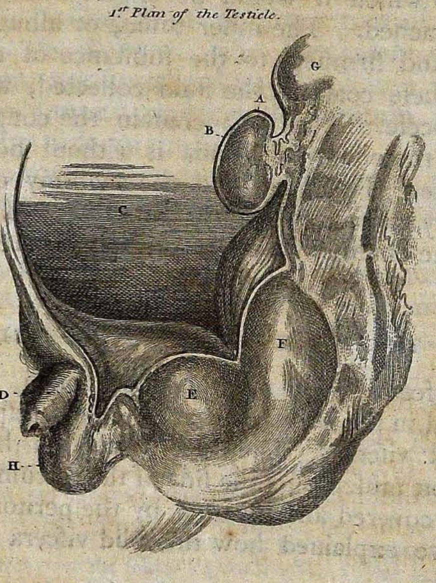
OF THE DESCENT OF THE TESTICLE *.

In the fœtus, ſome months before birth, the teſticles are lodged in the belly, and are in every reſpect like the abdominal viſcera. They are ſeated on the fore part of the pſoæ muſcles, by the ſide of the rectum. They are of courſe covered and inveſted by the peritoneum; for, as we have explained how the ſolid viſcera and the in-

* The deſcent of the teſticle was diſcovered, and the formation of the coats of the teſticle explained, by Mr. John Hunter. See *Animal Œconomy*. In reading *Kerckringius* one is apt to believe he underſtood the nature of the deſcent of the teſticle. Specilegium Anatomicum p. 35.

testines are behind the peritoneum, so it will be understood how the testicles lying on the loins are behind the peritoneum: that is to say, the glandular substance of the testicle is invested by a single coat, and that coat is the peritoneum, which, after covering the body of the testicle, is reflected upon the loins; as the coats of the liver, for example, are to be traced from its surface to the diaphragm: no words, however, can well explain this subject, and it will be better understood by sections and plans.

First Plan of the Testicle.



We see that the body of the testicle A is seated on the loins, that it is attached by vessels, and invested by the peritoneum. This surrounding of the body of the testicle by

by the peritoneum forms that coat which is in union with its ſubſtance, and which deſcends with it into the ſcrotum, and forms the tunica albuginea.

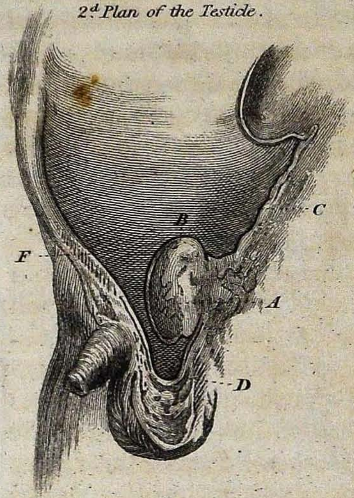
The figure and preſenting ſurfaces of the teſticle, while within the belly, are the ſame which we find after it has deſcended into the ſcrotum. It ſtands edge-ways forward, and the epididimis lies along the outſide of the poſterior edge of the teſtes. We ſee that it is attached, by the peritoneum being reflected off from its back part, and we can trace the peritoneum upwards over the kidney G, and downward over the rectum F, and bladder of urine E.

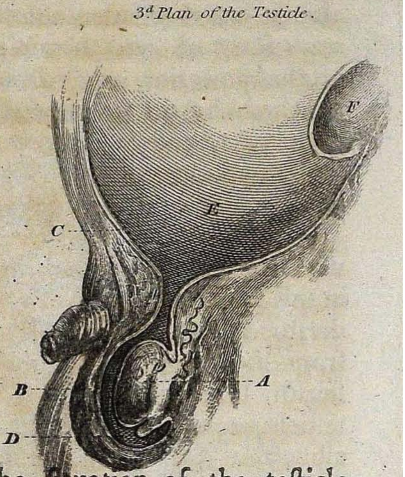
We may alſo obſerve a proceſs of the peritoneum which has paſſed through the abdominal ring, and which in this plan is marked D. Now it may eaſily be underſtood that the teſticle A, gradually ſhifting its place from its connections in the loins, drops down into this ſheath D. It will alſo be eaſily underſtood how the teſticle, covered with its firſt coat B, (viz the tunica albuginea,) when it has fallen into D, is inveſted by this ſac of the peritoneum, and that this laſt covering will come to be the tunica vaginalis. The tunica vaginalis is ſo called becauſe it covers the teſticle like a ſheath; that is, it does not univerſally adhere to the ſurface of the albuginea, as that coat does to the body of the teſticle.

Underſtanding the nature of the peritoneum, we may learn the meaning of this looſeneſs of the outer coat of the teſticle. By turning to the introductory ſection of the abdominal muſcles, we find, that the inſide of the ſac of the peritoneum is ſmooth, and forms no adheſion; whilſt the outer ſurface, being in contact with the ſubſtance of the ſeveral viſcera, has a connection with them by a common cellular membrane. Now, as the inſide of the peritoneum does not adhere as the ſurface of the peritoneum, (which in this firſt plan is towards C,) is ſmooth, and has no tendency to unite with the ſurface of the viſcera; ſo neither has the ſurface of the peritoneum at D, the tendency to unite with the peritoneum (or the ſurface of the albuginea,) at B,

when it deſcends to meet it ; conſequently the coat of the inteſtines may be repreſented in this ſecond plan, thus :

Second Plan of the Teſticle.





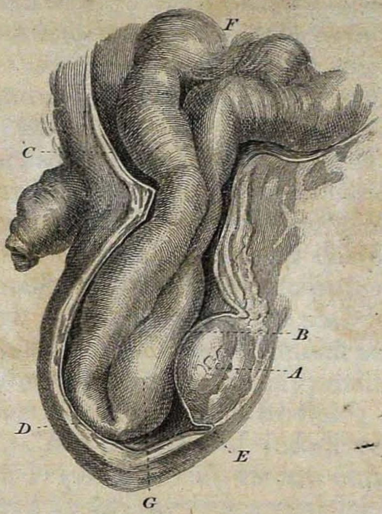
In the firſt plan we had the ſituation of the teſticle the fœtus repreſented. In the ſecond plan, we have middle ſtage of the deſcent repreſented : and, in the third, we have the full deſcent. In the ſecond figure, A is the body of the teſticle, B is the firſt peritoneal covering or tunica albuginea, which can be eaſily traced, reflected off from the loins at C ; again, D is the portion of the peritoneum, which having deſcended before the teſticle is preſently, when the teſticle has fully deſcended, to become the ſecond, or vaginal coat of the teſticle ; F is the continuation of the peritoneum upon the inſide of the abdominal muſcles.

In the third figure of this ſeries, we find the teſticle A has deſcended into the ſcrotum ; that it has one coat covering it, which we recognize to be the ſame with B, in the firſt figure, and that the peritoneum in this third plate at B, can be traced to C, the peritoneum within the belly.

Now ſuppoſing this to be the ſtate of the teſticle immediately after it has deſcended, we ſee that there is ſtill a com-

a communication betwixt the cavity of the tunica vaginalis D, and the cavity of the peritoneum E. F is the kidney, covered by the peritoneum, and nearly in the ſituation in which the teſticle was before its deſcent.

Fourth Plan of the Teſticle.



From this fourth plan of the teſticle, we may learn the nature of the congenital hernia. It is a hernia produced by the inteſtine ſlipping down, from the communication betwixt the general cavity of the peritoneum, and the cavity of the tunica vaginalis, or in conſequence of an adheſion betwixt the teſticle and a portion of the gut, which of courſe cauſes the gut to follow the teſticle, and prevents the communication betwixt the belly and the cavity of the tunica vaginalis from being ſhut. Thus fig. 4. A, is the teſticle, as is ſeen in plan 3d. B, the tunica albuginea; C, the peritoneum within the belly; D, the tunica vaginalis, which we can trace from C, and which is diſtended and ſeparated from the ſurface of the teſticle, (*i. e.* of the albuginea,) by a portion of the gut, which has deſcended through the ring; F, the inteſtines

 within

within the belly: G, the inteſtine which has fallen into the tunica vaginalis, and is in contact with the teſticle; that is, in contact with the tunica vaginalis, which is in cloſe union with the gland, and is conſidered as its ſurface.

We have explained the change which takes place in the ſituation of the teſticle, as it relates to the peritoneum; but how this change is brought about, it is very difficult to underſtand. It is not a ſudden pulling down of the teſticle, but a very gradual proceſs, continuing for months; it is not the effect of gravitation, for the fœtus may be in every variety of poſture while in the womb, and generally the head preſents. It is not reſpiration. Is it then the effect of the action of the cremaſter muſcle? or muſt we refer it to a law ſuch as that which controuls and directs the growth of parts?

When the parts in a fœtus before the deſcent of the teſticle are diſſected, there is found a ligamentous, or cellular cord, mingled with the fibres of the cremaſter muſcle, and which takes its origin from the groin, is reflected into the abdominal ring, and ſtretches up to the body of the teſticle. This body is called ligament or gubernaculum, and to the agency of this bundle of fibres, is the deſcent of the teſticle attributed. There are, however, objections to this. If we ſuppoſe that the cremaſter muſcle, by its exertion, brings down the teſticle to the ring, how does it paſs the ring? for ſurely we cannot ſuppoſe that this muſcle, which takes its origin from the internal oblique muſcle, conſequently within, can contract, not only ſo as to bring the teſticle to the very point of its origin, but to protrude it paſt that point, and through the tendon of the external oblique muſcle. Again, animals have the cremaſter muſcle, whoſe teſticles never deſcend out of the belly;—again, the veſſels of the cord, before the teſticle has fully deſcended, ſhow no marks of being dragged down, for they are elegantly tortuous.

As the teſticle paſſes very ſlowly from the loins to the ring; ſo, after it has eſcaped from the belly, it paſſes ſlowly from the ring to the bottom of the ſcrotum. It com-

commonly remains ſome time by the ſide of the penis, and only by degrees deſcends to the bottom of the ſcrotum *.

In this change the teſticles do not fall looſe into the elongation of the peritoneum like a piece of gut or omentum in a rupture ; — but, carrying the peritoneum with them, they continue to adhere to the parts behind them, as they did to the pſoas muſcle while in the loins: a point of importance to be recollected by the young ſurgeon.

The communication betwixt the belly and the ſac of the vaginalis is very ſoon obliterated by the adheſion of the upper part, and then the whole extent of the paſſage (viz. from E to D, in plan 3d of this ſeries,) is ſhut. When this proceſs is prevented in the firſt inſtance, when nature is baulked in the humour of doing her work, as Mr. Hunter obſerves, ſhe can not ſo eaſily do it afterwards.

It has alſo occurred that, this communication remaining after birth, a hydrodele has been produced by the diſtention of the tunica vaginalis, by fluids deſcending from the belly. The character of ſuch a tumour will be, that the fluid will be eaſily forced into the belly. It may, however, be miſtaken for a congenital hernia †.

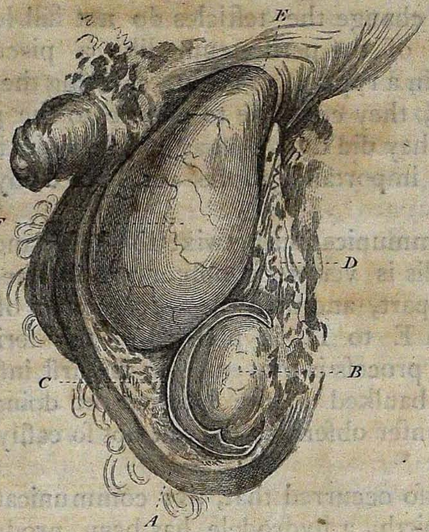
It will already be underſtood, that in the common hernia of the groin or ſcrotum, the gut does not paſs by the communication from the belly into the vaginal coat; that ſuch communication no longer exiſts, and that when there is a rupture from preternatural wideneſs of the abdominal ring, or in conſequence of a great violence, a new portion of the peritoneum deſcends with the gut before the cord of the teſticle.

* Mr. Hunter has ſhewn, that the detention of the teſticle in the belly is in conſequence of ſome defect and want of action in the teſticle, and that thoſe who have the teſticle remaining in the belly have it imperfect or ſmall. This is contrary to an old authority :— The teſticles are ſeated externally, " for chaſtity's ſake, for ſuch " live wights as have their ſtones hid within their body, are very " lecherous, do often couple, and get many young ones."

† Such is the remark of Mr. Hunter.

Fifth

Fifth Plan of the Testicle.



This 5th plan will now illustrate the relation of the testicle to the herniary sac in the common scrotal hernia. A, the scrotum: B, the testicle; which will be easily understood to preserve its attachment to the back part of the scrotum: C, the tunica vaginalis, which here invests the testicle, but which is not now (in the adult or perfect state of the coats of the testicle), as is seen in plan 3d, open from D to E, but forms a short sac surrounding the tunica albuginea: D, the cellular membrane of the cord of vessels passing down to the testicle. And now there are no remains of the tube of communication betwixt the belly and vaginal cavity; it is obliterated and resolved into this cellular membrane.

We see then, that in this plan the testicle and its coats, and the spermatic cord, are in their natural situation, and that the herniary sac has descended before them. E, is the ring of the external oblique muscle of the abdomen, through which not only the testicle, with its coats and vessels, has descended, but also the hernia: F, the herniary

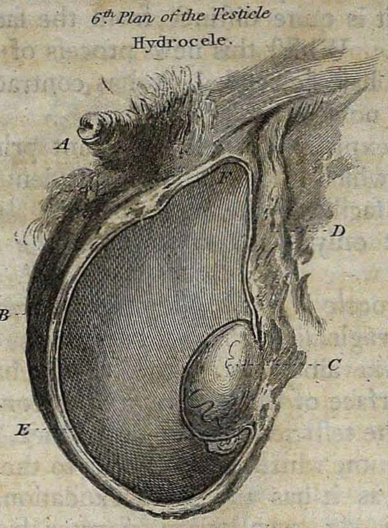
herniary ſac, which contains a portion of the gut; it is formed of the peritoneum, fallen down from the belly, but it is quite diſtinct from the ſac of the tunica vaginalis C. Whilſt this new proceſs of the abdominal peritoneum has deſcended, it has contracted adheſions, and cannot now be replaced.

In thus explaining theſe important principles of anatomy, and which the anatomical ſtudent will find wonderfully to facilitate the more minute ſtudy of ſurgical anatomy, it only remains to ſhow the nature of the hydrocele.

The hydrocele is a collection of water within the ſac of the tunica vaginalis; that is, betwixt the tunica vaginalis and tunica albuginea. For, as we have ſeen, that the ſame ſurface of the vaginal coat is contiguous to the ſurface of the teſticle (viz. the albuginea,) with that of the peritoneum, which is contiguous to the viſcera of the belly; and as it has the ſame exudation, ſo it has the ſame diſeaſe, viz. a collection of water, from the abſorption being diſproportionate to the exudation. When the tunica vaginalis is diſtended with the water of a hydrocele, the teſticle is towards the back part of the ſcrotum; it can be felt there; and when the ſcrotum is placed betwixt the candle and the eye, we ſee the tranſparent ſac on the forepart of the tumor, the opaque maſs of the teſticle behind; generally the diſtended vaginal coat ſtretches up before the cord conically: thus,

Sixth

Sixth Plan of the Teſticle.



A, the penis; it is generally corrugated thus, in conſequence of the diſtention of the ſcrotum in ſcrotal hernia and hydrocele: B, the ſcrotum: C, the teſticle, covered only by the tunica albuginea: D, the cellular membrane of the cord: E, the tunica vaginalis, diſtended with the water of hydrocele, and conſequently ſeparated from the ſurface of the teſticle: F, that part of the ſac of the vaginal coat, which often extends conically before the cellular membrane of the cord D. Now we ſee that the diſtention of the vaginal coat does not open up the old communication with the belly; but that, the former communication being ſhut, and the peritoneum there degenerated into the cellular membrane of the cord, the hydrocele is a diſtinct ſac, ſurrounding the teſticle, and formed of the tunica vaginalis.

To underſtand this ſubject of the coats of the teſticle, it is not neceſſary merely to conſider the deſcent of the teſticle; but the ſtudent muſt conſider it in every point of

of view, turn it as it were into every variety of poſture, without which his difficulties will perpetually return upon him. It is for this reaſon that I have endeavoured to repreſent ſimply the various ſtates of the coats of the teſticle in diſeaſe *.

OF THE VESSELS OF THE CORD AND TESTICLE.

In attending to the deſcent of the teſticle, we have a cue alſo to the vaſcular ſyſtem. If we did not know that the teſticles were originally placed in the loins within the belly, we might wonder at the length and origin of the ſpermatic veſſels.

THE SPERMATIC ARTERY riſes from the forepart of the aorta, below the emulgent artery, or from the emulgent artery, (generally on the right ſide,) and ſometimes from the arteries of the renal capſule: ſometimes there is only one, ſometimes there are two ſpermatic arteries. This artery, which the cord receives from the aorta or emulgent, is called the ſuperior ſpermatic artery, becauſe there is another which riſes from the hypogaſtric artery: this branch runs upward, connected to the vas deferens, as it riſes out of the pelvis.

Theſe arteries, taking their courſe under the peritoneum, join the faſciculus forming the cord, and ſupply the cord, and ſend twigs to the inveſting peritoneum; they then paſs through the abdominal ring, and in their courſe they are beautifully tortuous.

THE VEINS of the teſticle riſe on the right ſide from the trunk of the cava, a little below the emulgent vein, and from the emulgent vein on the left ſide. In the origin of theſe veins there are frequent varieties; there is

* *De Graaf* ſpeaks of the diviſion of the tunica albuginea into two membranes, probably meaning to diſtinguiſh the cellular tiſſue of the body of the teſticle from the inveſting membrane, *Morgagni* in his commentary on him tells us he can ſeparate the tunica albuginea into two lamina, the inner of which was the moſt delicate. Adverſ. An. iv. Animad. i.

Perhaps we might call the outer of theſe layers the *tunica vaginalis reflexa*, was it not more likely to confound the reading of our beſt authorities in anatomy than to aſſiſt us in demonſtration.

is alſo, accompanying the vas deferens, a vein, which joins the internal iliac vein. Theſe veins, in their courſe from the teſticle, are protected from the column of blood, and from the bad conſequences of compreſſion, by numerous valves. Theſe valves are very ſtrong, and will bear a great column of mercury before they give way or burſt. This plexus of convoluted veins of the cord is the moſt beautiful in the body. This convoluted ſtate of the veins is ever attendant on great activity and exertion of the arteries of the part. If there is a proviſion in the ſhape, courſe, and ſtrength of the arteries, for occaſional acceleration of the blood through them; ſo will there be found in the veins a tortuous and varicoſe appearance; and again, if by accident there is excited an uncommon action in the arteries of a living body, that action will be apparent from the diſtended or enlarged ſtate of the veins. In the teſticles of ſuch animals as have their ſeaſons, the artery and veins of the teſticle are ſtill more convoluted, and form a maſs of veſſels, which has been called the corpus pyramidale *.

The nerves of the teſticle, like the blood-veſſels, come from the loins, and are continued down upon the veſſels in the ſpermatic plexus. This ſtill farther allies the teſticle to the abdominal viſcera, giving them much of the ſame ſpmpathies. The ſtomach, inteſtines, and teſticle, ſympathiſe readily with each other. As we find the tunica albuginea of the teſticle to be very firm, denſe, and unelaſtic, the great pain in inflammation of the teſticle has naturally been attributed to the reſiſtance made by this coat to the ſwelling of the ſubſtance of the teſticle, but much muſt be aſcribed to the natural ſenſibility of the part, independently of ſwelling and tenſion; for in the very moment of a blow, a perſon faints and falls down from exquiſite pain.

* Corpus varicoſum,—Corpus Pampiniforme; Galen de Semine. Alias paraſtatam varicoſam, Hall.—As the old phyſiologiſts ſaw and obſerved this wonderful tortuoſity, and the tendril-like form of the ſpermatic artery, they thought that the blood was here begun to be changed into ſemen, and therefore they called them the *vaſa preparantia.*

The

The lymphatics of the teſticle are numerous, and eaſily demonſtrated by blowing up the cellular ſtructure of the body of the teſticle; and this, as we have ſeen, has been the ground of diſpute between phyſiologiſts; and the proofs of ſome important points in the doctrine of abſorption have been drawn from the injection of the lymphatics of the teſticle and chord.

The CREMASTER MUSCLE, as we have ſeen in the firſt volume, takes its origin from the internal oblique muſcle of the abdomen, and, paſſing down over the veſſels of the chord, is expanded on the tunica vaginalis: its uſe is to ſuſpend the teſticle, and prevent it from dragging upon the veſſels of the chord.

By conſtitutional weakneſs, or the relaxation induced by warm climates, this muſcle becomes relaxed, and artificial ſuſpenſion becomes neceſſary. Sometimes this muſcle draws the teſticle ſpaſmodically to the groin; yet I cannot allow that this is the muſcle which retracts and corrugates the ſcrotum, for the teſticle will be thus drawn up by the cremaſter, without corrugation or contraction of the ſcrotum. In ſome this would appear to be a voluntary muſcle: it poſſibly accelerates the motion of the ſemen, or at leaſt promotes its ſecretion.

Thus we find the chord of the teſticle, as it is called, to conſiſt of the excretory duct; of the arteries, veins, and nerves; of the lymphatics returning from the teſticle; of the cellular tiſſue embracing and ſupporting all theſe veſſels; and laſtly, of the fibres of the cremaſter muſcle.

OF THE STRUCTURE OF THE TESTICLE.

It is to De Graaff that we owe the knowledge of the ſtructure of the teſticle; and indeed the merit of this great anatomiſt has not been acknowledged with ſufficient gratitude by modern anatomiſts: but after the fervour of diſputation has ſubſided, the merit of ingenuity and of diſcovery muſt return to him to whom it is due. No one more highly values than I do the improvements of anatomy by the Hunters and Monro: but I muſt

 ſay,

ſay, that the ſtructure of the teſticle was demonſtrated by De Graaff to his fellow anatomiſts of Montpelier; and his diſcoveries publiſhed in a manner ſo perfect, as to leave us little to learn from more modern authors.

De Graaff, by exciting animals to venery, and tying the ſpermatic cord, had the ſeminal veſſels diſtended. He did not depend upon injections; by maceration and diſſection in this diſtended ſtate, he unravelled all the intricacies of their tubes. More modern anatomiſts have proved the truth of his obſervations by injections of mercury, and have ſucceeded in a variety of ways of preparing the teſticle.

Tubuli testis.—When the tunica albuginea teſtis is lifted, the body of the teſticle is found to conſiſt of innumerable very delicate white tubes; which, when diſentangled from the minute cellular membrane which connects them, and floated in water, exhibit a moſt aſtoniſhing extent of convoluted veſſels. By a cloſer attention, however, to this ſtructure before it is thrown into confuſion by pulling out the tubes, they appear to be regularly laid in partitions of the cellular membrane. Theſe ſepimenta are very regular in ſome animals, and while they ſeparate the ſeminal tubes, they ſupport and convey the blood-veſſels to the ſecretion of the ſemen. Dr. Monro has denied the formal diviſions which De Graaff had engraved, but acknowledges them leſs regular, leſs eaſily found, and not ſo limited in their number; nor does he find them to prevent all communication betwixt the tubes of the teſticle.

Theſe ſeminiferous tubes of Haller, or tubuli teſtis of Monro, run towards the back of the teſticle. Each of theſe tubes ſeems to be cylindrical, or of one diameter throughout their whole extent: we ſee no communication betwixt them; no branches given out or going into them; no beginning for the whole, nor for any one of them. There ſeems to be only one tube wonderfully convoluted and folded up in each ſubdiviſion of the teſticle.

Rete testis.—When the tubuli come out from the body of the teſticle, they run along the back of it, and communicate by inoſculations with each other, ſo as to

form

form a net-work of veſſels, from which appearance Haller named them rete teſtis.

Here it often happens that the mercury ſtops, when it has been injected backward from the vas deferens; and it is this part which has been better deſcribed and drawn, in conſequence of mercurial injections, than it was by De Graaff; for he, as we have ſaid, ſaw this part only filled with ſemen.

Connected with the rete teſtis is the CORPUS HIGHMORIANUM.—Where the lines of the membranous ſepta, and cellular membrane of the teſticle, meet on the back of the teſticle, and under the epididimis, they form a white line. This white line running along the teſticle, was ſuppoſed by Highmore to be a hollow tube; it was compared with the ſalivary duct; it was thought to be a cavity leading from the body of the teſticle to the head of the epididimis, and to form the communication by which the ſemen flowed from the teſticle. De Graaff firſt refuted this notion, and ſhewed that it was not by this one great duct, but by theſe ſmaller tubes forming what has been now called the rete teſtis, that the ſemen came from the teſticle: ſtill it had continued a queſtion, whether this white line was really ſolid, or a tube; and upon faithful examination of the point it appears, that this is expreſsly as it was explained by De Graaff, viz. that it is a mere collection of the membranes of the body of the teſticle, forming a linea alba; and as the ſepta are more diſtinguiſhable in ſome animals, ſo is the corpus highmorianum*.

VASA EFFERENTIA.—The tubes running on the back of the teſticle, and forming the rete teſtis, we have underſtood to ariſe from the tubuli teſtis; now it is the continuation of the rete teſtis which is called vaſa efferentia. The vaſa efferentia are very delicate veſſels which run out from the head of the teſticle, ſingle at firſt, but they are ſoon convoluted, and by theſe convolutions they are formed into an equal number of *vaſcular cones*, which conſtitute the head or larger part of the epididimis. Theſe vaſa efferentia and vaſcular cones are connected

* This body is called a mere *firmamentum* or binding.—Winſlow.

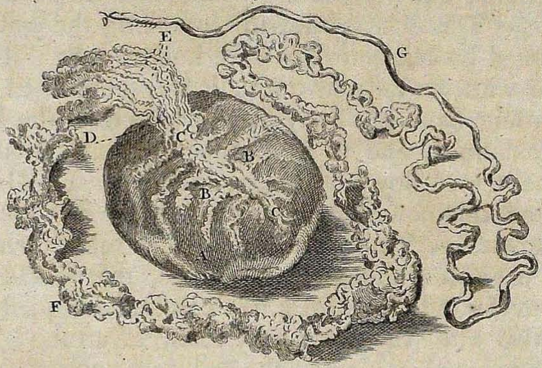
 by

by a very delicate cellular membrane; and it is a piece of very nice diffection to difplay them after they are injected with mercury.

EPIDIDIMIS.—The vafa efferentia, after forming three conical convolutions, unite and form larger tubes; thefe again uniting, and form one large excretory duct, the *vas deferens*: but this veffel being convoluted to a wonderful degree, forms a body, which, being as it were placed upon the tefticle, has been called epididimis.

Plan of the Tefticle.

7th Plan of the Testicle. p. 195.



In this reprefentation of the diffected tefticle, A is the body of the tefticle divefted of its coats; B, the tubuli teftis*; CC, the rete teftis; D, the vafa efferentia; E, the vafcular cones; F, the epididimis, formed of the convolutions of the vas deferens; laftly, G is the vas deferens.

In the fubftance of the tefticle there are no glands nor folicules; the arteries minutely ramify amongft the feminal tubes, and, there is reafon to believe, fecrete the femen into them. The feminal veffels in the fubftance of the tefticle, or tubuli teftis, run together upon the fur-

* Where the tubuli are emerging to form the rete vafculofum they are called the *vafa recta*.

face

face of the teſticle, and form the rete teſtis. From the rete teſtis are continued the vaſcular cones: theſe convolute, and running together form the epididimis; from which the tube is continued under the name of the vas deferens. It paſſes up the chord, enters by the ring into the abdomen, and then, paſſing down into the pelvis, terminates in the veſiculæ ſeminales, in a manner preſently to be explained. It is not likely that the vis a tergo, the power of the arteries, puſhes the ſemen through all this length of tube, of which the epididimis itſelf is reckoned to be ſeveral feet in length, if the various convolutions were undone; ſuch an action on the teſticle as that of the dartos or cremaſter muſcle, could give only a general preſſure but could not force on the ſemen in tubes which take ſo great a variety of directions. We are therefore left to the ſuppoſition, that theſe tubes themſelves have a power of accelerating the fluids through them.

Of the lymphatics of the teſticle we ſhall afterwards treat; it is, however, neceſſary here to remark, that Prochaſka found in his injections a difficulty in making the mercury paſs the rete teſtis into the teſticle. Obſerving at the ſame time in his preparations, and in the drawings of all authors, an appearance of irregularities in this part like the valvular ſtructure of lymphatics, he has been led to ſuppoſe that there is a proviſion here for preventing the ſemen from being forced backward into the teſticle by the action of the cremaſter muſcle; he conceives that when the cremaſter muſcle draws up the teſticle to the groin, it may accelerate the ſemen in the epididimis, whilſt this valvular ſtructure prevents the regurgitation upon the delicate veſſels of the ſubſtance of the teſticle.

The annexed plate repreſents the appearance which I have found in my preparations. A, the vas deferens by which the mercury was injected; B, the epididimis; C, veſſels running up the chord from the great head of the epididimis: but in ſucceſsful injection, there is no ſuch appearance.

There is a duct which sometimes arises from the epididimis, and which has been found to terminate abruptly in a blind end—of this, Mr. Hunter speaks in the annexed note *.

OF THE TESTICLE IN GENERAL.

The testicle is of an oval form, and of the size of a pigeon's egg: it is a little flattened on the sides: it hangs in the scrotum by the spermatic chord; one end of the oval, forward and high; see plan 8th, B; while the other is backwards, and drops lower, C. The spermatic cord consists of the artery which brings blood; of the veins which return it; of the vas deferens, which carries the semen to the vesiculæ seminales at the neck of the bladder; of lymphatics, which are essential to the structure of every part. This cord of vessels comes down from the belly, and passes by the ring of the abdominal muscles: it is about four inches in length, and is fixed into the upper and fore part of the body of the testicle.

The body of the testicle is easily distinguished, and is the place where the secretion is performed. It is strictly the body of the gland, while the part above it is only the duct by which its fluid is discharged.

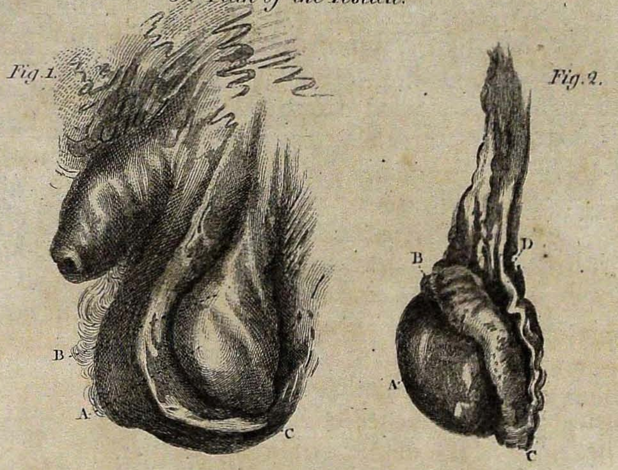
* "By a supernumerary vas deferens, I mean a small duct, which sometimes arises from the epididimis, and passes up the spermatic cord along with the vas deferens, and commonly terminates in a blind end, near to which it is sometimes a little enlarged. I never found this duct go on to the urethra, but in some instances, have seen it accompany the vas deferens as far as the brim of the pelvis. There is no absolute proof that it is a supernumerary vas deferens; but as we find the ducts of glands in general very subject to singularities, and that there are frequently supernumerary ducts, there being often two ureters to one kidney, sometimes distinct from beginning to end, at other times both arising from one pelvis; these ducts, arising from the epididimis, I am inclined to believe from analogy, are of a nature similar to the double ureters. They resemble the vas deferens, as being continuations of some of the tubes of the epididimis, are convoluted where they come off from it, and afterwards become a straight canal passing along with it for some way, when they are commonly obliterated.

"The idea of their being for the purpose of returning the superfluous semen to the circulation is certainly erroneous, from their being so seldom met with, and so very seldom continued further than the brim of the pelvis."

The ancients called the testicle dydimi, gemini, twins; they, therefore, called that part which is laid on the back of the testicle epididimis, as added to it. To the surgeon, it is essentially necessary to attend to the relation of the parts of the testicle as felt through the scrotum.

Eighth Plan of the Testicle.

8th Plan of the Testicle.



In this 8th plan, fig. 1. we see the testicle as in its natural situation, covered with its membranes, and appearing like one body; while, in the second figure, it being represented freed from its outer coat, we see the epididimis as laid upon the testicle, and consisting of the convoluted tube. First, we observe A, the body of the testicle; B, the beginning of the epididimis, or the large head of the epididimis*: then we see it laid alongst the back of the testicle, and observe C to be the small head of the epididimis †, where the tube is reflected to reascend upon the testicle, and to form D, the vas deferens.

* *Globus major*, or head.

† *Globus minor*. This part we often distinguish retaining its hardness after the subsiding of the general swelling of hernia humoralis. From this point we can trace all the connections of the other parts.

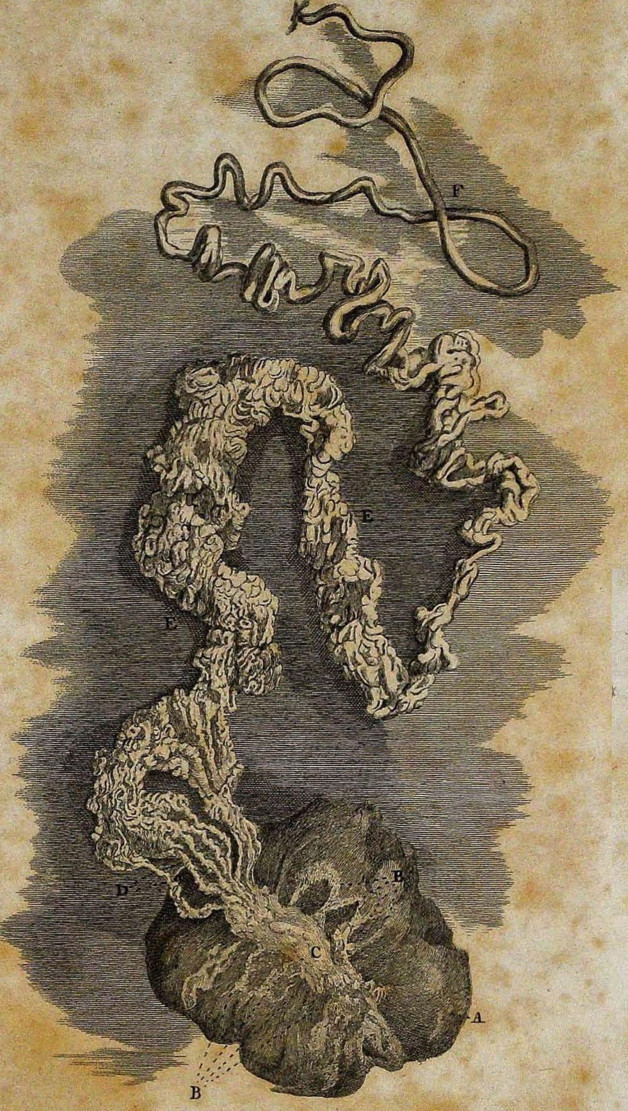
Now, we have to obſerve, that the point C, fig. 2. or ſmall head of the epididimis, hangs over the teſticle, and points backwards to the perineum, and can be felt though the whole coats; and that the body of the teſticle A, is towards us when we examine a patient — Further, as the letters in figure 1 and 2. refer to the ſame points, we have only to notice the fainter indication of the parts in fig. 1. it being inveſted with the coats; and to obſerve the general relation of the teſticle to the ſcrotum and penis.

There is one other circumſtance to be obſerved, viz. that the epididimis is always laid on the outer ſide of the inſertion of the chord into the teſticle; from which we diſtinguiſh, with eaſe, in a preparation, to which ſide the teſticle belongs. Thus, in the annexed plans, the teſticle of the left ſide is repreſented, which we know from the points c, being directed backward, while the epididimis is laid along the left ſide of the inſertion of the chord.

OF THE VESICULÆ SEMINALES.

Behind the proſtate gland, and attached to the loweſt part of the urinary bladder, lie two ſoft bodies, which are the veſiculæ ſeminales. They appear like ſimple bags when ſeen from without, but diſſections ſhow them to conſiſt of a cellular ſtructure: each of theſe bodies is about three fingers-breadth in length; their backmoſt point is large and round, and, at the ſame time, that they diverge from each other, their narrow points unite, or are contiguous to each other forwards, and enter at the back part of the baſe of the proſtate gland.

As we have ſeen, the peritoneum does not deſcend far enough betwixt the bladder and rectum to cover or inveſt theſe veſiculæ; they are therefore involved in the cellular texture, and covered with ſtrong fibres, beſides being ſubject to the compreſſion of the levator ani muſcle. When the veſiculæ are cut into, and eſpecially when they are diſtended, dried, and cut, they preſent a cellular



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cellular appearance; but if they are carefully diffected, they prefent the appearance of a fmall blind inteftine convoluted.

This cellular appearance is given by the duplication of their inner membrane, together with the diftortions and curves of the canal. Their outer furface is covered with a fine membrane, which, connects thefe cellular convolutions.

Thefe are copioufly fupplied with arteries: their furface is covered with veins and lymphatics when thefe veffels are minutely injected, and their coat is thick and fpongy. Heifter, Winflow, and others, have defcribed fmall glands as feated in their finuofities; but thefe are confidently denied, and in their place there is defcribed a pile or efflorefcence. There can be little hefitation in affirming, that thefe veficulæ are themfelves glands, or in other words, that the arteries fecrete into them a peculiar fluid. The fore part of each of the veficulæ, which we have faid fink into the back part of the proftate gland, run under the neck of the bladder, and open by diftinct mouths into the urethra, on the furface of the verumontanum.

The connection of the vas deferens with the veficulæ is very particular; it does not open directly into them, but opens with them into the urethra in fuch a way, that the femen from the tefticle can pafs into the veficulæ though its direct courfe is into the urethra *.

If air be blown into the vas deferens, the veficulæ will be diftended, at the fame time that the air paffes into the urethra: at the union of the extremities of the vas deferens and veficulæ, the two ducts run a little way together and then unite fo as to open into the urethra by one mouth.

The extremity of the vas deferens joins the duct of the veficulæ where it is imbedded in theproftate gland; the union of the vas deferens and duct of the veficulæ is not attended with an enlargement of the duct; on the contrary, as the duct paffes forward deep into the fub-

* See explanation of plate III.

ftance

ſtance of the gland to arrive at the urethra, it becomes remarkably narrower until it opens in a very ſmall orifice in the verumontanum, as we ſee repreſented in the third plate. The duct (if we may ſo call it) of the veſiculæ paſſes a full inch forward into the gland before it terminates in the urethra.

Theſe veſiculæ have been in general ſuppoſed to be receptacles for the ſemen; but as this is an opinion depending on the connection of theſe bags with the extremities of the vas deferens, and as comparative anatomy ſhows many inſtances of theſe veſiculæ being unconnected with the ducts of the teſticle, there is much reaſon to doubt whether they really are merely reſervoirs. They appear to me as uſeful in adding a fluid to the ſecretion of the teſticle, which being poured together into the ſinus of the urethra, are then ſufficient to diſtend this part, by which too the ejaculator muſcle is exerted and effect given to its action; for a ſmaller portion of fluid would not be carried forward by its contraction; unleſs there were a proviſion of fluid ſufficient to diſtend the ſinus of the urethræ, the ſemen could not be thrown out from the urethra. This ſuppoſition is not oppoſed by the facts ſtated by Mr. Hunter, that in many animals the veſiculæ and vaſa deferentia open by diſtinct foramina into the the urethra, becauſe in that caſe the fluids of theſe ſecreting bags might be equally mingled with the ſemen in the ſinus of the urethra although they do not flow from the ſame tube.

Verumontanum.—The verumontanum, or caput galinaginis, is an eminence on the lower part of the urethra, where it is ſurrounded by the proſtate gland. As we obſerve in the drawing, it is larger and round towards the bladder, and ſtretches with a narrow neck forwards. On its ſummit, the two orifices of the ſeminal veſſels open; and around it there are innumerable leſſer foramina and mucous folicules.

THE

ANATOMY

OF THE

FEMALE PARTS OF GENERATION.

THE

ANATOMY

OF THE

FEMALE PARTS OF GENERATION.

THE ANATOMY OF THE PARTS IN THE FEMALE PELVIS.

THERE is confiderable difficulty in prefenting fuch a view of the anatomy of the parts of generation in woman, as may bear a due relation to this general fyftem of anatomy, and, at the fame time, be intelligible and complete. The fubject is in itfelf extenfive and important, fufficient to fill feveral volumes: it is much connected with practice; and the phænomena and difeafes of the fyftem ferve greatly to illuftrate the ftrict anatomy of the parts. I cannot here be allowed to give to it its due importance, whilft yet it is a fubject not eafily underftood from a fhort abftract.

The parts of generation are divided into the external, which are thofe without the pelvis; and the internal, or vifcera of the pelvis, and which lie within the bony circle of the pelvis.

CHAP. I.

THE EXTERNAL PARTS OF GENERATION.

The external parts of generation are the mons veneris, labiæ, clitoris, nymphæ, urethra, hymen, or carunculæ myrtiformes. Upon theſe ſubjects we have no want of books and information; for accoucheurs of the old ſchool dwelt upon the deſcription with particular accuracy. Theſe parts were within their ken, which we cannot ſay of the viſcera of the pelvis: and therefore, upon the former we ſhall be more brief.

In very young children theſe external parts bear a large proportion to the body, greater than at any ſubſequent period before the age of puberty. At puberty they are ſuddenly and completely evolved, and acquire an increaſe of ſize; while, from the age of two years to twelve or thirteen, there has been little increaſe. Immediately before menſtruation, commences the connection which occaſions or accompanies that flux. It begins to effect the evolution of the uterine ſyſtem, and to fit it for its peculiar function. The parts become turgid and vaſcular; the fat is depoſited in the ſurrounding cellular membrane. About the fortieth year, when the menſes diſappear, this fulneſs of the private parts alſo ceaſes, and the fat is reabſorbed.

The MONS VENERIS is that prominence on the ſymphyſis pubis, which conſiſts of the ſkin raiſed and cuſhioned up by the fat incloſed in the cellular membrane; there is of courſe a great variety in its ſize. In early life it is ſmall: it becomes, as we have ſaid, more prominent at the age of puberty; in fat women it is of an enormous ſize; and in ſome warm climates a particular laxity prevails. From the hair on this part, marking the age of puberty, it is called pubes. As the lax texture admits of diſtenſion with the fluid of anaſarca, it is ſometimes from this cauſe very greatly ſwelled.

The LABII. Theſe are often named alæ, from a ſlight reſemblance to wings, and they are alſo called externæ, magnæ, or majores, from their place, and from their ſuperiority in reſpect of ſize over the nymphæ. The labii ſeem to be the mons veneris continued downward, and laterally until meeting below, they form the vulva; at their lower angle by their union they form the fourchette, or frenum labiorum. The ſtructure of the labiæ is ſimilar to that of the mons veneris; ſometimes one is larger than the other.

The great ſenſibility of the membrane which lines the inſide of the labii requires ſome defence, and therefore the whole ſurface is amply ſupplied with mucous folicules and glands. The labii are a protection to the other ſoft parts, ſo neceſſary, that the clitoris, or nymphæ, when they project beyond them, are ſubject to violent inflammation.

The parts here have either ſuch folds, or are of ſo lax a texture, as to permit a great degree of diſtention during the paſſage of the child. But as the labii have no muſcular power, and depend entirely on their elaſticity for reſtoring them to their original ſize, they commonly, after being very much dilated, remain in ſome degree larger and more lax. It is different with muſcular parts, as the orificium externum, which, by the power of its ſphincter, is reſtored after labour to its original ſize. In man, hernia deſcends from the abdominal ring into the ſcrotum; but, in woman, when there is a rupture from the ring (which is rare), it falls into the labium.

The NYMPHÆ are named labii vel alæ minores, or labiæ internæ, to diſtinguiſh them from the great labii. They are like a miniature repreſentation of the great labiæ; they are covered with a very delicate membrane, and have great ſenſibility. They begin immediately under the glans clitoridis, and ſeem to be only an extenſion of its preputium, formed by a folding of the membrane. Their ſize varies much. They commonly ſtretch downward, and backward to the middle of the orifice of the

the vagina; ſometimes no further than to that of the orificium urethræ, and in a few inſtances they extend even the length of the fourchette*. They are very vaſcular, and have ſomewhat of a cellular ſtructure, and thus partake of a degree of turgidity, in conſequence of irritation and vaſcular action. The moſt modeſt of the uſes aſcribed to them is, that of directing the ſtream of urine. As they are obliterated during the paſſage of the child's head through the vulva, it is probable that they facilitate the neceſſary dilatation.

The nymphæ are, in their natural ſituation, covered and completely protected by the labii externi. When naturally large or increaſed by diſeaſe, or in a very relaxed ſtate, they are deprived of this covering: they project from under the labii, and are apt to become inflamed, and even to ulcerate. The original diſeaſe, or tumor, is augmented, or they become perhaps hard and callous. In children they bear a very great proportion to the other parts, and are more conſpicuous and prominent than in the adult. Their diſeaſed enlargement ſometimes requires to be extirpated, in which operation as they are very vaſcular, and as with their growth, their blood-veſſels enlarge, conſiderable hæmorrhagy may be expected. A ſurgeon of this city, in extirpating a tumor of this kind from a young lady, thought his duty fulfilled when he had applied a piece of lint upon the ſurface after the operation, ſo that he even neglected to appoint an attendant. The hæmorrhagy returned, and continued ſo profuſe that before the ſurgeon arrived the lady had fainted and was in danger.

The CLITORIS is ſimilar to the male penis. Like the penis, it conſiſts of cells for receiving blood, and in a ſimilar manner, it ariſes from or takes hold of the rami of the os pubis by two crura; theſe unite at the ſymphyſis pubis, to form the body of the clitoris,

* Both Riolin and Morgagni have ſeen the parts without the nymphæ.

which

which is fuſpended from the os pubis, like the penis, by a kind of ligament. The clitoris has alſo a kind of glans, over which the integuments make a fold like a preputium. In ſhort, it has the ſame ſenſibilities, the ſame power of erection with the membrum virile; only it has no urethra nor ſpongy body, like that of the urethra of man.

The ſtories of the increaſe of this inſtrument, even to its pre-eminence in ſize over the male penis, are very idle, but there ſeems to be a peculiar predilection for them. It is not wonderful that a clitoris of ſuch magnitude ſhould ſuggeſt the idea of a hermaphrodite, or perſon partaking equally of the diſtinguiſhing attributes of either ſex.

OF THE URETHRA.

The urethra of the female is ſhort, ſtraight, and wide; its length an inch and a half, or two inches; its direction nearly ſtraight, or only ſlightly bending under the os pubis; and its diameter ſuch as will admit a catheter the ſize of a writing quill. The conſequences of theſe peculiarities are, that the catheter is eaſily paſſed when there is no very unuſual obſtruction; that women are not ſo much expoſed to the diſeaſe of ſtone in the bladder as men, for though this is much owing to conſtitutional peculiarities, yet it is obvious, that when a ſmall ſtone is formed, and paſſes from the bladder, it is eaſily diſcharged; and, laſtly, that lithotomy is a very ſimple operation in woman.

The opening of the urethra is in a direct line under, or behind the clitoris, and about an inch from it: it is in the middle of a ſlight prominence, and its vicinity is plentifully ſupplied with mucous glands. If the relation of the orifice to the clitoris be obſerved, there is, in the natural ſtate of the parts, no difficulty in ſlipping the point of the catheter, on the end of the middle finger, from the clitoris, until it is caught upon the lacuna-like orifice of the urethra; but even in this part of the operation, I have experienced great embarraſſ-

ment, from an irregular ulcerated or cancerous ſurface of the parts, by which all the uſual diſtinctions were loſt.

From the length and ſudden turns of the male urethra, from the double function it performs, and from its being embraced by the proſtate gland, the obſtructions of the urine are more frequent, and the catheter leſs eaſily paſſed, than in woman. The catheter too requires to be of a very peculiar form. The ſhort and wide urethra of woman requires only a ſimple and almoſt ſtraight tube: and although, accurately to adapt it to the courſe of the urethra, a conſiderable curve might be given to it, yet that is not neceſſary in common caſes; and circumſtances will occur to the accoucheur which will preclude the poſſibility of uſing ſuch an inſtrument.

We ſhall only mention here ſuch caſes of obſtruction of urine as are in a particular manner illuſtrated by the anatomy and connection of the parts. Theſe are tumors of the ovarium, tumors of the womb, polypi, diſtenſion of the vagina, diſplacement of the womb, as procidentia, prolapſus, retroverſio, &c.; and laſtly, the child's head in labour.

The ovarium being enlarged, and falling down into the pelvis, either preſſes upon the neck of the bladder, cauſing obſtructions, or preſſing and weighing on the fundus of the bladder, it occaſions a ſtillicidium urinæ.

Tumors of the womb, eſpecially of the neck or orifice, as it is in contact with the urethra, very ſoon affect this organ. Thus, I have ſeen a cancer of the orifice of the womb, by exciting inflammation in all the ſurrounding parts, and by maſſing them together into a tumor filling the pelvis, occaſion obſtinate obſtruction of urine.

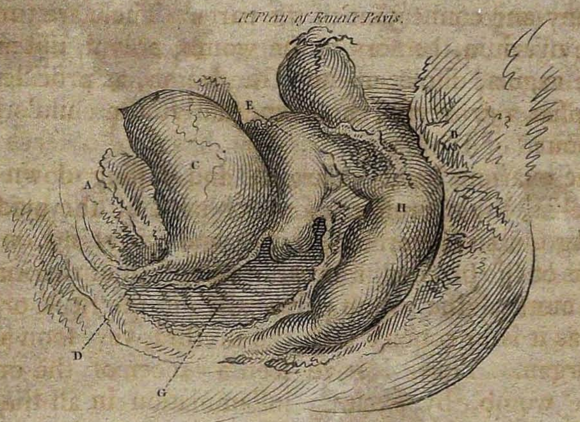
Polypi attached to the orifice of the womb, and filling the vagina, produce the ſame effect. In all ſuch caſes, perhaps, the tumor may be puſhed up, ſo as to permit the flow of urine, or the introduction of the catheter.

A caſe occurred to Mr. John Bell, in which the tumor of the womb compreſſed the neck of the bladder. A catheter was paſſed, and gave inſtant relief. The midwife,

midwife, after ſome time came, and ſaid, that the catheter would not paſs. He found that he could paſs the catheter into the bladder, but no urine flowed; and it was diſcovered, that the tumor increaſing backward, came to preſs upon the ureters, ſo as completely to obſtruct them where they enter the bladder. The woman unavoidably died; each kidney and ureter was found to contain four or five ounces of urine.

A ſlight ſketch of the parts in the female pelvis will, perhaps, better explain the connections of the neck of the bladder than any deſcription, and will certainly better illuſtrate the cauſe of ſome kinds of obſtruction, particularly that ariſing from the change in the poſture of the womb.

Firſt Plan of the Female Pelvis.



A, the os pubis cut through. — B, the ſpine and ſacrum alſo cut directly down. — C, the urinary bladder moderately diſtended, and riſing behind the pubes. — D, the urethra, very ſhort, and taking a gentle curve under the ſymphyſis of the os pubis. — E, the fundus of the womb. — F, the os tincæ, or orifice of the womb. — G, the vagina. — H, the rectum.

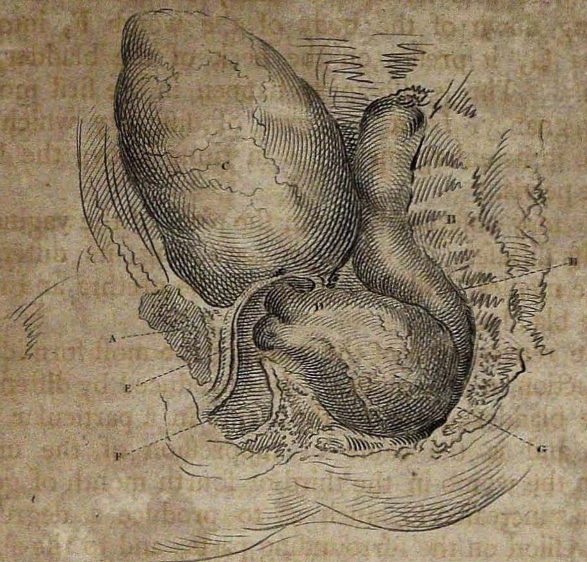
 Prolapſus,

Prolapſus, or falling down of the womb, is frequent with thoſe who have born many children. By this ſlipping down of the body of the womb F, into the vagina G, it preſſes on the neck of the bladder, or urethra. This is alſo apt to happen in the firſt months of pregnancy, from a degree of difficulty which the womb in its enlargement has in riſing above the brim of the pelvis.

We may obſerve alſo from the place of the vagina G, that its diſeaſes, its ſcirrhous hardening, its diſtention by the menſes, will alſo compreſs the urethra and neck of the bladder.

The retroverſion of the womb is the moſt formidable obſtruction to the urethra. It is produced by diſtention of the bladder acting on the womb in a particular ſituation, and is the cauſe of ſuppreſſion of the urine. When the womb in the third or fourth month of geſtation has increaſed ſo much as to produce a degree of compreſſion on the ſurrounding parts, and to riſe above the brim, and ſhoot up into the abdomen, a diſtention of the bladder is apt to throw the fundus under the projection of the ſacrum. We have to obſerve the connection betwixt the back and lower part of the vagina. By the diſtention of the bladder, the vagina is ſtretched, and the orifice of the womb is raiſed, which throws back the fundus of the womb, ſo that this comes to be the ſituation of the parts.

Second Plan of the Female Pelvis.



A, the os pubis; B, the ſacrum; C, the bladder of urine much diſtended, and riſing above the pubes; D, the connection betwixt the back part of the bladder and the upper part of the vagina, and through which the riſing of this part of the bladder (in conſequence of its diſtention) has drawn up the orifice of the womb, and thrown back the fundus. E, the orifice of the womb, which being raiſed and turned up, no longer preſents ſo as to be felt by the finger in the vagina. It will be obſerved alſo, that the womb now lying acroſs the pelvis, this lower part is forced againſt the neck of the urethra, ſo as to compreſs it, and cauſe total obſtruction of urine. F, the vagina, which is ſtretched in conſequence of the riſing and turning up of the orifice of the womb. G, the fundus of the womb enlarged and diſtended by impregnation, fallen back under the promontory of the ſacrum, and compreſſing the rectum H.

Now, when the fundus of the womb is thruſt back, and the orifice raiſed by the diſtention and conſequent

riſing of the bladder, the natural and ſimple cure is to introduce the catheter, and draw off the urine. But ſhould this not be done at firſt, then there being diſtention of the bladder, and preſſure on the rectum, the abdominal muſcles ſympathize with theſe parts, ſo that bearing-down efforts are made, and the fundus of the womb is forced further down into the hollow of the ſacrum, while the orifice is directed upward.

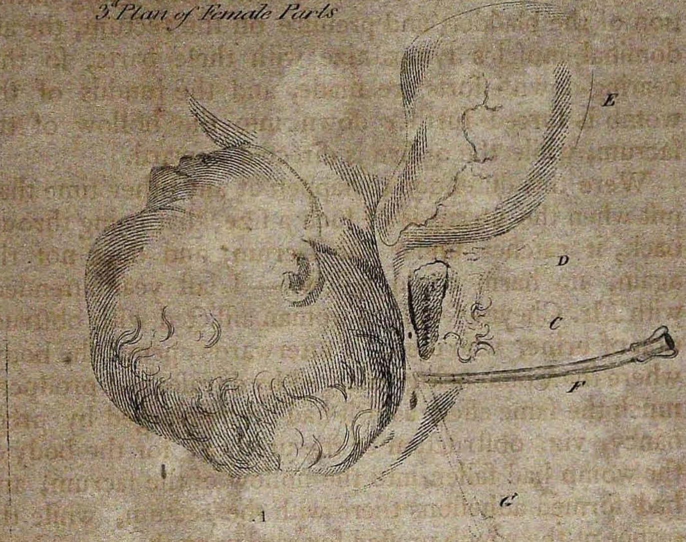
Were this diſtention to happen at any other time than juſt when the uterus is of ſuch a ſize, that being thrown back, it catches under the ſacrum; and does not riſe again, no harm could follow. — I laſt year attended, with Mr. Cheyne ſenior, a woman afflicted with obſtruction of urine, who died. I afterwards opened the body, where the womb being enlarged by diſeaſe, had produced much the ſame effect as if it had been enlarged by pregnancy, viz. obſtruction of the urethra; for the body of the womb had fallen into the hollow of the ſacrum, and had formed adheſions there with the rectum, while the orifice of the womb preſſed forward upon the os pubis, ſo as to produce an obſtruction of urine. The parts were otherwiſe diſeaſed, but this was one cauſe of the obſtinacy and fatal determination of the complaint.

As we treat of thoſe ſubjects only as connected with the urethra, we may obſerve, that ſometimes the urethra takes a courſe not round behind the os pubis ſimply, nor ſtraight upwards, but curved backwards, ſo that the convexity of the catheter requires to be towards the ſacrum, to allow the point to paſs over the orifice of the womb, or perhaps the flexible or the male catheter may be required.

The effect of the wedging of the child's head in a tedious labour, is to elongate and compreſs the urethra in a very particular manner. Many young men have felt the difficulty of introducing the catheter in this caſe. But it is a difficulty proceeding generally from ignorance or inattention. I have never ſeen a caſe in which the compreſſion was ſo great as to prevent the paſſing of the catheter. But often practitioners forget the direction which the urethra neceſſarily takes, when the child's head has ſunk into the pelvis.

Third

Third Plan of the Female Parts.



Thus, when in the ſecond ſtage of the labour, the child's head A, has ſunk into the pelvis, the urethra C, is preſſed betwixt it and the os pubis D. The urine conſequently collects in the bladder, and the bladder E, riſes above the brim of the pelvis, and I have found it ſtretching to the ſcrobiculus cordis. There is danger from the diſtention of the bladder, and the labour-pains ceaſe. Now the young ſurgeon or accoucheur, introduces the catheter in the uſual way, in the poſition F, of courſe he finds great difficulty, and gives pain in the attempts. But after inſerting the point of the catheter, he muſt incline its handle much towards the perineum, as in the inclinations of the dotted lines G, ſo that the point may glide up in the direction betwixt the child's head and the pelvis.

ORIFICIUM VAGINÆ. This is alſo named ORIFICIUM EXTERNUM, in deſtinction to the uterine orifice. I notice

tice it under the head of the external parts, becaufe we have to fpeak of the parts which furround the orifice as the hymen.

The orifice of the vagina of the human female is abridged by the hymen, which is a peculiar membrane. It is of a femilunar form, and fometimes furrounds the lower part of the orifice of the vagina; — commonly it furrounds only the lower half of the circle, though it would feem to vary confiderably in fhape, place, and ftrength. It has been found furrounding the whole circle of the orifice, leaving only a fmall hole in the centre, or upper part; or it is defcribed as perforated with leffer holes, allowing the evacuation of the menftrual blood. In other cafes, it has been found a complete feptum, preventing the evacuation of the menftrual blood. — This is a fact which I do not difpute, for I know that the perforation for the evacuation of the menftrual blood is fometimes neceffary. When I have feen the imperforated vagina in the child, it was not the hymen which clofed the orifice, but an adhefion of its fides; yet this adhefion, if it had come to be diftended with the menftrual blood of feveral periods, would have prefented the appearance of a tenfe membrane ftretched acrofs the orifice.

Such femilunar membrane as I have defcribed, will occafiuoally be feen in the female parts; but it has fuch an appear ance as may eafily be deftroyed in the preparation of the parts, if the anatomift be inattentive or carelefs. It is neither a guard, nor is its exiftence a teft of female chaftity. Often in tender children there is no fuch thing to be feen; while, on the other hand, it has been cut to admit of labour and delivery *. Either of thefe facts is fufficient proof of the idle notions entertained concerning this membrane. It has been a favourite topic in all ages,

* I need not fay how unneceffary and improper fuch operations are. All rigidity, calofities, even tumors, and undoubtedly the hymen, will yield to that general relaxation of all the parts, which takes place upon the commencement of labour.

and

and in all ſituations. The ſavage, and the gentleman, make much the ſame enquiries on viſiting a muſeum; and ſuch was the ſubject of Omai's ſpeculations in the muſeum of Dr. Hunter.

THE CARUNCULÆ MYRTIFORMES—are ſmall and irregular tumors at the back, or lower part of the external orifice; they are ſeated rather at the ſides than exactly at the back part; they are generally ſuppoſed to be the ruins of the hymen, which being lacerated, ſhrink into two or three tumors on each ſide. Some have ſaid, that theſe exiſt originally joined together by a thin membrane, or delicate tiſſue of ſmall veſſels, the rupture of which cauſes an effuſion of blood. They ſeem to be ſimply corrugations of the inner membrane, which ſerve as a poſition for the dilatation of the parts; and they accordingly diſappear during the paſſing of the child's head.

THE FOSSA NAVICULARIS is a ſinus, ſuppoſed to be of the ſhape of a boat, whence its name. It is formed betwixt the proper orifice of the vagina and the fourchette, or joining of the labii at their lower edge. It is more conſpicuous in young ſubjects.

From the meeting of the labii below, the PERINEUM commences: it includes the ſpace from the frenum to the anus.

CHAP. II.

OF THE PARTS CONTAINED WITHIN THE FEMALE PELVIS.

THESE parts are the bladder of urine, the vagina, the womb, the ovaria. We ſhall conſider them under diſtinct ſections.

SEC-

SECTION I.

OF THE BLADDER OF URINE.

As the coats of the bladder of urine in woman do not vary from thofe of the male bladder, we have under this head only to notice the peculiarities in its relative fituation. It is feated behind the os pubis, and betwixt it and the womb; and on its lower part it is attached to the vagina; upon the neck of the bladder, or the beginning of the urethra, there is not a body like the proftate gland; and, as we have feen, the urethra is fhort, wide, and ftraight, and fimple in its ufe.

Women are not fubject to calculi, and the operation for the ftone is rare in them; for, as already obferved, when the nucleus is formed, or when a ftone flips down from the pelvis of the kidney, it paffes from the bladder with much greater facility than in the male parts. The urethra of itfelf has been known to dilate fo, as to allow very large ftones to pafs, or it has been artificially dilated. Indeed the old operation for lithotomy, was rudely to dilate, or rather tear, the urethra, and the modern operation is fimply to thruft the gorget along the grooved ftaff, fo as to lay open the fide of the urethra and neck of the bladder, by an incifion above the vagina. Sometimes nature has effected her own relief by the ftone working from the neck of the bladder into the vagina.

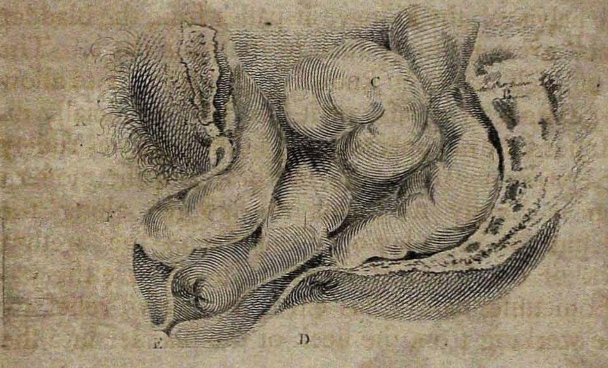
A woman had for a very long period fuffered great diftrefs, not only the ardor urinæ, frequent defire to make urine, with the urine turbid and bloody, and with all the ufual fymptoms of ftone violently aggravated; but fhe was delicate and timorous, and concealed her diftrefs until the urine had run for fome time by the vagina. After fhe had been exhaufted by long fuffering, her friends infifted that fhe fhould allow an examination, when a ftone was found partly in the bladder, with one of the rough ends projecting into the vagina. The opening was enlarged, and the ftone extracted.

We

We muſt, in all caſes, recollect the connection of the upper part of the vagina and orifice of the womb, with the back part of the bladder. We have ſeen its effect in producing retroverſio uteri. We muſt alſo attend to this connection, as tending to the diſplacement of the bladder in the procidentia uteri. The uterus ſinking into the vagina, and the upper part of the vagina being at the ſame time reflected into the lower part, pulls down the bladder with it, and when (the diſeaſe increaſing) the womb covered by the vagina comes to hang from the external parts, it has happened that the bladder has ſunk down and lain upon the fore part of the tumor, but of courſe within the everted vagina.

4th Plan

Section shewing the effect of Procidentia on ye Bladder.



Thus, by comparing this fourth plan with the firſt of the female pelvis, we may judge of the nature of this diſplacement of the womb, and its effects on the bladder of urine.

A, the os pubis; B, the ſacrum; C, the inteſtines come into the ſituation of the womb; D, the uterus fallen down, and carrying the vagina before it; E, the vagina ſtill covering the womb, but the orifice of the womb appearing, which is generally diſtorted and irregular; F, the bladder, which from its attachment to the

forepart of the vagina, has been dragged down, but is now within the vagina.

In ſuch diſplacement of the bladder, the urethra becomes diſtorted from its natural direction, there is an obſtruction of urine, and the catheter is with great difficulty introduced. We ſhall, perhaps, have to turn the handle of the catheter in various directions after introducing the point, and by chance get it introduced at laſt.

SECTION II.

OF THE VAGINA; OF ITS SHAPE, CONNECTIONS, ETC.

THE vagina is a tube ſtretching from the external orifice to the orifice of the womb. Its orifice is bounded below by the fourchette; above by the arch of the pubis; and directly over it, or ſometimes within it, is the orifice of the urethra; below, are the carunculæ myrtiformes. It is ſurrounded by faſciculi of fibres, which are called the ſphincter muſcle. The canal of the vagina is of a conical form. At the outer orifice it is conſtricted by the ſphincter muſcle: but it is wider within, and where it receives the orifice of the womb. It may be diſtended to almoſt any degree, but naturally its ſides, by their own elaſticity, or the contraction of the ſurrounding fibres, or the preſſure of the ſurrounding parts, are in contact.

In the natural ſtate, the orifices of the vagina and womb, are but three or four inches diſtant, often only two; and ſometimes, where there is a degree of relaxation, they are nearly in contact. In the firſt months of pregnancy, the orifice of the womb is kept down by the degree of difficulty the body of the womb has in ſhooting up from the brim of the pelvis. But the gravid uterus riſing above the pelvis in the latter months, draws up the orifice of the womb and ſtretches the vagina.

 The

The vagina bends gently round the pubis as it were, or follows the axis of the pelvis; and as the interior of two circles cut off by the ſame radii is the ſhorter, the vagina is longer behind than before.

And thus (*in this fifth plan*) the forepart of the vagina A, is ſhorter than the back part B. We may obſerve from this plan alſo, that the orifice of the womb C, projects as it were into the vagina, ſo that the finger touches the os tincæ, and chiefly its anterior lip, without reaching the upper part of the vagina.

The vagina takes its curve nearly in the centre of the pelvis; it is of neceſſity attached by cellular ſubſtance to the rectum and bladder. The urethra, as we have ſaid, opens above the orifice, and that canal is attached to the vagina in its whole length; and the neck of the bladder is attached to the upper part. In conſequence of this natural connection, diſeaſe of the vagina ſometimes throws the whole parts, the rectum, vagina, and bladder, into one fiſtulous ulcer.

The vagina has three coats; that is to ſay, it has the inner coat, or ſurface, a few muſcular fibres, and around it a condenſation of the ſurrounding cellular membrane, which may be conſidered as the third coat.

The

The internal, or villous coat, is a reflexure of the delicate covering of the external parts. It is of larger extent, or longer than the others; and is therefore tucked up into rugæ, which run acrofs the vagina. They are more remarkable on the fore and back part of the vagina; they are lefs in married women, and confiderably obliterated by repeated labours.

To fupply a vifcous fecretion for the defence of this furface, mucous glands are numeroufly, but irregularly fcattered over it, and they are particularly numerous at the orifice.

The mufcular coat is not very ftrong, nor are the fibres diftinct, from which fome have fufpected their exiftence, alledging, that there is here only condenfed cellular membrane, and that the contraction of the vagina is the effect of mere elafticity. I obferve fo great a profufion of venous vafcularity, that I prefume the vagina fuffers an inflation of its coats, and confequently contraction from an afflux of blood to it. The mufcular fibres are, however, as we have faid, gathered into fafculi near the orifice, fo as to be diftinctly vifible.

The firmnefs and ftricture of the vagina fupport the womb; the dilatation of the vagina, the relaxation which old age, and frequent labours produce, occafion the falling down of the womb. It is a difeafe almoft peculiar to thofe who have borne many children, to the old, weak, and relaxed, and to thofe who are fubject to the fluor albus; every flux from the womb, or difcharge from the vagina, having a remarkable effect in relaxing the parts.

This, from the nature of the parts, muft be an increafing difeafe; for no fooner has the womb fallen down into the vagina, than it becomes a fource of irritation, excites a bearing-down pain-like tenefmus, an uneafy fenfation, a defire to make urine, and an obftruction of urine; all which is explained by the connection of the parts. The womb lodging in the vagina dilates the orifice, and preffes long on the perineum, at laft it is entirely forced out, and the prolapfus uteri becomes the procidentia uteri: it is in truth a hernia of the womb.

The

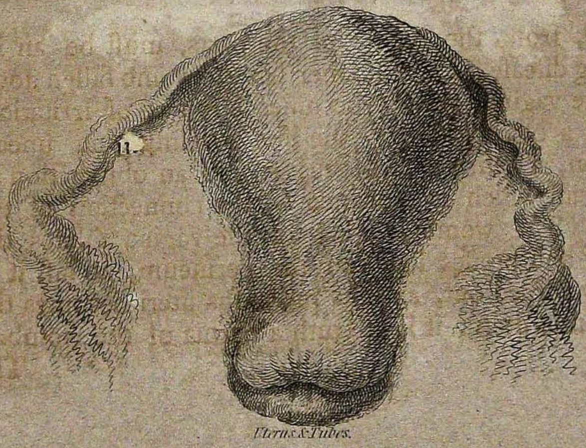
The third, and outer coat, as we have ſaid, is formed of the cellular membrane, by which it is connected with the ſurrounding parts; but the peritoneum comes down upon the upper part of the vagina. This is the reaſon why a portion of the inteſtine, when it ſlips down betwixt the vagina and rectum, forms a kind of hernial tumor in the vagina, and why the water of the aſcites has puſhed down the back of the vagina, ſo as to make a bag capable of being punctured to draw off the water.

For the greater ſpace, however, the outer cellular coat of the vagina connects it with the urethra on the fore-part, and with the rectum behind. From which cloſe connection of parts, we ſee the conſequence of the delay of the child's head in the ſecond ſtage of labour, that the head lies violently diſtending, and compreſſing the parts, while the woman, exhauſted by the previous ſtage, is unable to complete the delivery. From violent inflammation, with a deficiency of ſecretion, there ariſes a cold and flabby ſtate of the parts. When the woman is delivered, the parts have ſuffered ſo much, that they ſlough off; ſometimes the urethra is laid open on the fore part, and ſometimes the rectum behind.

SECTION III.

OF THE WOMB.

6th Plan of ye F. Parts.



Uterus & Tubes.

THIS

This little drawing will better explain the figure of the womb, when diffected from the vagina and furrounding membranes, than the ufual reference to a bottle, a pear, or a powder-flafk. As, indeed, it refembles no familiar object that I know, we muft, for the convenience of defcription, diftinginguifh it into thefe parts: — The upper part, or FUNDUS, which is that part above the going off of the Fallopian tubes. The BODY of the uterus, which is that larger part betwixt the fundus and the narrowing below; THE CERVEX, which is the narrow neck; and the OS TINCÆ, or orifice formed of the bulging lips, which project into the vagina, of courfe that part over which the inner membrane of the vagina is reflected. We diftinguifh alfo the two furfaces, for the womb is of a flattened form. The anterior furface of the body of the womb is convex, but the pofterior furface is confiderably more fo, and even during geftation it keeps this relative figure.

The whole fize of the uterus is about three inches in length, and two in breadth, but there is a very great variety in this refpect, from age, the effect of pregnancies, and other caufes. When, in its ufual fituations and relations, the fundus is on a level with the brim of the pelvis, or a very little below it. In the fœtus, the womb is like the bladder, confiderably above the brim of the pelvis; but, in a few weeks the pelvis enlarging, it finks deeper, and foon affumes the fame fituation as in the adult.

FALLOPEAN TUBES. From the lateral obtufe angles formed betwixt the fundus and the body of the uterus, the Fallopean tubes are continued. Thefe tubes may almoft be confidered as a continuation of the uterus, did not we find them fo very diftinct in their fubftance. They are about three inches in length, take a tortuous courfe, and their extremities have an unequal fringed termination, which is called the FIMBRIÆ *. Their canal is very fmall towards the uterus, but enlarges; and is patulous towards the extremities. Thefe canals are the

* Morfus diaboli.

commu-

communications by which the ovum formed in the ovarium is carried down into the womb.

LIGAMENTS OF THE UTERUS. To ſupport the uterus from ſinking too deep into the pelvis, and to ſteady it, and direct it in its aſcent during pregnancy, anatomiſts have generally aſſigned as the uſe of the ligaments. But whatever good they may do in the latter operation, they are certainly unfit for the former.

There are four ligaments of the uterus.

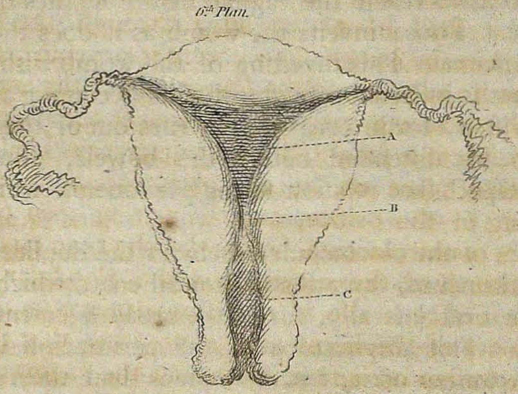
The BROAD LIGAMENT of the uterus is formed of the peritoneum; for this membrane paſſing down before the rectum, and aſcending again, and covering the neck, body, and fundus of the womb, deſcends on the fore part, ſo as to reach the vagina before it riſes over the bladder. Thus it inveſts the womb as it does the abdominal viſcera. This inveſting of the womb with the peritoneum is indeed a proviſion for its becoming an abdominal viſcus, for in pregnancy it riſes out of the pelvis; and, being diſtended before the bowels, aſſumes in every reſpect that relation to the peritoneum which they have.

As the womb is included betwixt the duplicature of the peritoneum, it is this peritoneal coat, which being continued off laterally, forms the broad ligament of the womb. This duplicature of the peritoneum being a thin expanſion of it, has ſometimes had the name of ALÆ VISPERTILIONIS: It is in truth like a myſentery to the womb and Fallopean tubes, and ſerves equally to ſupport and convey the veſſels to them. The womb and theſe two ligaments make a complete partition running acroſs the pelvis.

From the ſide of the uterus, a little below, and before the going off of the Fallopean tubes, the ROUND LIGAMENTS ariſe. I conſider theſe ropes as ligaments, but they are totally unlike any common ligament. They ſeem intended to give the due inclination forward, and to direct the uterus in its aſcent in pregnancy, and accordingly they are not merely condenſed and elaſtic cellular membrane; but, on the contrary, they are compoſed of fibres, with an intermixture of blood-veſſels, ſo that whilſt they

they keep a degree of tenſion on the uterus, they yield and grow not only in length, but in thickneſs and ſtrength, as the uterus aſcends in the advanced pregnancy: they paſs through the abdominal ring, and are attached to the cellular membrane of the top of the thigh. In the gravid uterus, both the broad and the round ligaments conſiderably alter their poſition, appearing to riſe lower, and more forward from the womb than the unimpregnated ſtate. This is in conſequence of the greater increaſe of the fundus of the womb, in proportion to the lower part of it.

OF THE CAVITY OF THE UTERUS.



The cavity of the uterus is properly confined to the fundus and body, and takes a triangular figure. In the cervix, it is more like a canal, and differs eſſentially from the proper cavity. A, *the cavity of the uterus;* B, *the continued cavity*, where it is very narrow towards the cervix. C, *the canal of the cervix*, where it has an enlargement like a ſinus. The Fallopian tubes are ſeen going off from the cavity of the uterus. Theſe angles of the cavity admit no more than a hog's briſtle. The third angle, towards the neck, is, of courſe, conſiderably larger. The proper triangular cavity of the uterus is lined with a peculiar ſoft and delicate membrane; it is very vaſcular, and the veſſels either open on the ſurface

naturally or burſting out from time to time, pour out the menſtrual blood. The canal of the cervix ſhows a very different ſurface. We obſerve a prominent longitudinal line on the fore and back part of it from which oblique and tranſverſe rugæ go out. The ſurface is firmer and callous, and leſs vaſcular. Betwixt the rugæ there are lacunæ, which throw out a mucilaginous fluid; and towards the orifice we ſee theſe larger, and ſometimes diſtinct glandular bodies.

This peculiar ſhape of the cavity of the womb, and the hardneſs and ſmall degree of vaſcularity of the lower part, is of the moſt eſſential importance. The upper part, the proper cavity of the womb, is prepared for the reception and immediate adheſion of the ovum, when it ſhall have deſcended through the Fallopean tube; but the long callous cervix is provided, that there may be no adheſion to the lower part of the womb, and that the placenta may not form over the orifice of the womb, for if it ſhould, the moſt dangerous kind of flooding takes place on the approach of labour, from the opening of the orifice, and the tearing open of the adheſions of the placenta, before the child can be delivered. The length of the cervix, and the glandular ſtructure of the orifice is alſo of much importance in ſealing up the cavity of the womb after conception, that there may be no longer communication with the vagina; for this purpoſe, a viſcid tenacious mucus is poured out; but, on the approach of labour, with the ſoftening and relaxation of all the ſoft parts, this adheſion and gluing up of the orifice is diſſolved, and a more fluid ſecretion is poured out.

From the cavity of the womb the MENSTRUAL BLOOD is diſcharged at certain periods, from the time of puberty to the approach of old age, when the ſyſtem is no longer capable of giving nouriſhment to the fœtus. We ſhall preſently find, that the ſubſerviency of menſtruation merely to the preparation of the ſurface of the womb for the reception of the fœtus, though it be a principal, is by no means the ſole end of this periodical diſcharge.

 It

It was long diſputed from what ſource the menſtrual diſcharge flowed. Some affirmed, that it muſt flow from the vagina, and not from the womb, becauſe it flowed ſometimes during geſtation. This is a fact which cannot be denied. I have attended a patient who menſtruated during the entire period or to the eighth month; and I have often obſerved ladies to menſtruate at the firſt period after conception. On the other hand, we have every proof the diſcharge being from the orifice of the womb. For inſtance, ſome have obſerved on diſſection of the parts of women dying during the flow of menſes, that blood was effuſed under the delicate membrane of the cavity of the womb. The veſſels there have been obſerved particularly turgid, or the whole ſurface of the proper cavity, and eſpecially the fundus, ſpotted with bloody effuſions. More particular obſervations has ſhewn not only the mark of blood poured out from the inner ſurface, but that the whole ſubſtance of the womb was become thick, ſoft, and vaſcular *; and M. Littre affirms that in the body of a woman who had died during menſtruation, and with a conception in the Fallopean tube, he found a layer of red coagulated blood; upon removing which he ſaw a number of ſmall foramina which admitted briſtles †.

But the beſt and leaſt equivocal proof is, that which has been repeatedly obſerved in the inverſion of the womb, when the inner ſurface has been turned out after labour, and has remained thus inverted, and protruding from the external parts, for then the menſtrual blood has been ſeen to diſtil from the ſurface of the cavity of the uterus.

* The authorities upon this ſubject are Spigelius, Morgagni, M. Littre, Mouriceaux, Winſlow, Sympſon.

† This might have been an early abortion, or perhaps the decidua which it is ſaid is ſometimes formed at the menſtrual period.

OF

OF THE BLOOD-VESSELS OF THE WOMB.

Thefe are four large arteries which fupply the fyftem of the womb, and four large veins which return the blood.

The SPERMATIC ARTERIES come down from the aorta itfelf, or from the renal or capfule arteries. The fpermatic artery taking a waving direction, becomes tortuous in a moft remarkable degree as it approaches the uterus, it is diftributed to the Fallopean tube, the ovarium, but chiefly to the body and fundus of the uterus, where it forms remarkable anaftamofes with the artery of the other fide.

The LOWER ARTERY—the UTERINE ARTERY, comes in general from the hypogaftric artery, takes alfo a ferpentine courfe, and is diftributed to the vagina, and the lower part of the uterus, and inofculates largely with the other veffels, both in the uterus, and by parti-cular branches on the fide of the uterus.

In the firft place, it appears, that this copious fupply of veffels to the uterus, from four different fources, is a provifion that the womb and fecundines fhall not by any accident of pofition, or by the progrefs of labour and the confequent compreffion of one or both the lower veffels, be deprived of their due fupply of blood. Again their tortuous forms give proof of their occafional greater activity, that they admit of a peculiar and local action during menftruation, and that the blood will move more languidly when the ftimulus of the womb has ceafed. It is alfo a provifion for the growth and increafe of the womb, and the fupply of nourifhment to the ovum. And that an increafed activity in a part muft be fupplied by a more tortuous form, as well as an enlargement of the calibre of the veffels is in a particular manner illuftrated by the change which takes place in thefe veffels during pregnancy. For they become in a much more remarkable degree tortuous and enlarged.

The fubftance of the uterus is faid to be fpongy and compact, which though it is a feeming contradiction in words

words does yet really convey an idea of the effects of the intertexture of veſſels in it. Some have ſaid, (as Moriceau,) that by pregnancy the womb is diſtended, and grows thinner: others, that it grows thicker, as Daventer: and others again, as Smellie, aſſert, that it continues of its natural thickneſs. Theſe aſſertions are none of them perfectly correct; for the womb is not diſtended by the growth of the fœtus and membranes, but grows with them. Again, that the ſubſtance of the womb grows in a remarkable degree is true, but ſtill when diſtended by the waters in the laſt months of pregnancy, its walls are thinner than in the unimpregnated ſtate. Thus, when it has been cut in the living body, upon the approach of labour, as in the Cæſarean ſection, I have obſerved it, not more than a quarter of an inch in thickneſs, even at the part to which the placenta adhered. When I have diſſected the womb after a tedious labour, the waters diſcharged, but the head wedged in the pelvis, I have found it conſiderably thicker. And, laſtly, in the full contraction of the womb, after expelling the fœtus and placenta, (for example, in rupture of the womb, where the child and placenta had been forced amongſt the bowels, and the woman ſoon after died,) I found the walls of the womb about three quarters of an inch in thickneſs.

SECTION IV.

OF THE OVARIA.

THE OVARIA, are two oval bodies, which are ſuſpended in the broad ligament behind, and a little below the Fallopian tubes: while they have an oval figure, they are ſomewhat flattened. By cutting out the ovaria, the animal loſes the power of conceiving, and deſire is extinguiſhed; they, therefore, beſtow what is eſſential to generation upon the part of the female. In vague ſpeculations on the ſubject of generation, they were ſuppoſed

posed to prepare a female semen! but more particular examination demonstrates that they consist of vesicles which are ova; but how far incomplete, or in what essential circumstance requiring the approach of the male is not determined.

When we hold the section of the ovarium betwixt the eye and the light, we see a great many pellucid vesicles; and if we examine the ovarium of an animal killed in full health, and particularly in the season, we shall observe these ova to be in all varieties of states of preparation for impregnation. Some small and pellucid, and yet only discernable in the thick outer coat, by having a degree of greater transparency; others which have taken a slight tinge of bloody colour from vessels striking into them; and if the section be made after a minute injection, the vesicles will be seen coloured in the proportion of their maturity; some without a speck of colour; others tinged; one or two loaded with injection; and some vascular, and particularly prominent.

In very young girls, the substance of the ovarium is whitish, and very soft; the surrounding membrane is thick; and the round corpuscles scarcely discernable; and no irregularities, nor any of those bodies called corpora lutea, are to be seen on the surface. But as the girl advances in years, the little vesicles begin to appear, and when about ten years of age, or just before menstruation, the ovarium is full of ova of various sizes, and some of them more matured, and forming an eminence upon the surface. In the adult woman, the substance of the ovarium which appeared as an uniform homogenous mass in the fœtus, is become a cellular and vascular bed, giving nourishment to those numerous vessels or ova. Before impregnation can take place, there must be a certain state of preparation of the ovaria, without which the approach of the male effects no change in the uterine system. The lower animals having their seasons, and these seasons being a state of preparation for the male, impregnation follows the copulation with much certainty; but, in woman, such a periodical revolution in their system, and instinctive desires, would but ill accord with

that ſuperiority in attributes of the mind, which diſtinguiſh us in the ſcale of beings. But women alſo ſuffer ſuch an occaſional excitement in the uterine ſyſtem, though unaccompanied with deſire, which preſerves the womb in a ſtate of preparation for the reception of the ovum, and the ovaria in a ſtate of preparation for impregnation. This is the effect of menſtruation.

OF PUBERTY.

AUTHORS have long, with many expreſſions of ſurprize, laboured to aſſign a cauſe, or frame a theory for the explanation of thoſe changes which we obſerve in woman at the age of puberty: and generally, in their theories, they have connected with theſe changes the monthly and periodical diſcharges of blood from the uterus, which commences with puberty. Theſe theories have been founded in general on principles remote from the laws of a living ſyſtem. At this period of puberty the whole frame is expanded into the fullneſs of feminine beauty; the breaſts rapidly increaſe, and are matured; the parts of generation are enlarged; the hair of the pubis grows, and the menſes flow. In explanation of theſe changes, theoretical conjectures after this model have been entertained. "About this time the growth of the body begins conſiderably to diminiſh, and the blood finding eaſy admittance into the completed viſcera is prepared in greater quantity, the appetite being now very ſharp in both ſexes, a plethora conſequently follows. In the male it vents itſelf frequently by the noſe, from the exhaling veſſels of the pituitary membrane being dilated, &c.; and now the ſemen firſt begins to be ſecreted, and the beard to grow. But, in the female, the ſame plethora finds a more eaſy vent downwards, being that way directed, partly by the weight of the blood itſelf to the uterine veſſels, now much enlarged, of a ſoft fleecy fabric, ſeated in a looſe hollow part, with a great deal of cellular fabric interſperſed, which is very yielding and ſucculent, as we obſerve in the womb: for theſe cauſes, the veſſels being eaſily

easily distensible, the blood finds a more easy passage through the very soft fleecy exhaling vessels which open into the cavity of the uterus, as being there less resisted than in its return by the veins, or in taking a course through any other part; because, in females, we observe the arteries of the head are both smaller in proportion, and of a more firm resisting texture. The return of the same is, therefore, more slow, both because the flexures of the arteries, from the increased afflux of the blood, become more serpentine and fit for retarding the blood's motion *, and likewise, because it now returns with difficulty through the veins. The blood is therefore first collected in the vessels of the uterus; next, it is accumulated in the arteries of the loins, and the aorta itself, which urging on a new torrent of blood, augments the force so far as to discharge the red blood into the serous vessels, which at first transmit an increased quantity of warm mucus, afterwards a reddish coloured serum, and by suffering a greater distension, they at last emit the red blood itself. The same greater impulse of blood determined to the genitals, drives out the hitherto latent hairs, increases the bulk of the clitoris, dilates the cavernous plexus of the vagina, and whets the female appetite to venery, &c."

We cannot have trust to such weak and inconsistent theory, we cannot believe in this plethora, produced by the diminished growth of the limbs; neither can we believe that congestion and plenitude is produced in the female system, from the deficiency of perspiration, from their more lax and weaker solids compared with man, from their indolent and sedentary life: for facts are in direct contradiction, The growth and completed function of parts at this particular age, is not to be explained by any theory so partially applicable; during almost every period of life, there are similar changes taking place in some one part of the body. Parts lie dormant, and are

* I have shown that the tortuous arteries always form a provision for the occasional increase of the action and acceleration of the blood.

stationary

ſtationary in their growth, which at a particular and ſtated age of the animal, enlarge and develope themſelves by a new and invigorated action. Obſerve how different the proportions of the fœtus are from thoſe of the adult. We ſee nature careful to perfect certain parts, as the head and liver, at an early period. We ſee during early childhood how the parts ſhoot out, and evolve in due proportion. We ſee parts which were large in the fœtus loſe their preponderance: we ſee others, which ſerved ſome purpoſe in the fœtal ſyſtem, gradually ſhrink and diſappear, becauſe they have no longer the ſtimulus to action in the circle of connections which take place in the adult ſyſtem. We find other parts, as the teeth for example, lying long within the jaw, inſtead of proceeding with a gradual and continual enlargement, ſuddenly riſing at certain ſtated periods from their embryo ſtate, and enlarging and puſhing up through the gums, when it becomes fit that the child ſhould take more ſolid food than the mother's milk. So the ſecond ſet of teeth in a more particular manner, lie quite ſtationary in their growth within their little ſacs, yet quickly, at ſtated periods, they increaſe, the enamel is formed, and they riſe above the gum. There is an infinite number of ſuch changes depending upon the ſame laws of the œconomy, and not different from thoſe which controul the growth, and direct the ſhape of parts. They depend upon certain laws of the conſtitution, which give an excitement to certain parts, at ſtated periods, and which no theory partially applicable will explain. There is a ſeries in which the parts of an animal body are matured, and a ſucceſſion in which the functions are brought to maturity: and in the female conſtitution, there are laws determining an action upon the womb and breaſts, and all parts ſubſervient to conception and the nouriſhment of a fœtus; at that period when the woman is arrived at the age fit to take upon her the part of a mother.

OF

OF MENSTRUATION.

UNDER this head, I ſhall confine myſelf to ſuch a general view of the ſubject, as is neceſſarily connected with the peculiar functions we are now endeavouring to comprehend.

Menſtruation is a ſtate of preparation for conception. When, therefore, the menſes flow at the natural periods, and in due quantity, it is a ſign that the woman may conceive, and that her ſyſtem is fit for the ſupport and nouriſhment of a child. It is a general affection of the ſyſtem, which has a tendency to relieve itſelf by a topical action, by the excited action of the uterine ſyſtem; and this excitement of the uterine ſyſtem is the end which nature is accompliſhing. To explain this, I may be allowed to take a ſhort preliminary view: each particular organ or viſcus, whilſt it has its connections with the general ſyſtem, is, in truth, a ſyſtem within itſelf, having its peculiar functions, ſympathies, and even vaſcular action, in a certain degree independently. Were not this, in ſome meaſure, the caſe, we ſhould ſee no local diſeaſe or topical action; and no vaſcular action could be for a moment ſtationary and confined to one part. The body would, indeed, be then only one great hydraulic machine. But while the ſeveral parts have the property of being excited ſeparately to an accelerated action, they are actuated by remote ſympathies, and by theſe ſympathies and relations is the whole ſyſtem in a great meaſure ſupported.

Before menſtruation commences, there is a preceding indiſpoſition, and ſymptoms indicating a conſtitutional affection. And theſe complaints are uſually more ſevere in the firſt than in the ſubſequent periods. The general revolution in the ſyſtem begins to accumulate its action towards the womb, and thoſe ſymptoms uſually accompanying uterine irritation, ſhow how far it is affected, and in a little time the menſes flow. Now, I conceive the flow of the menſtrual blood to be, not the end which nature is here labouring to accompliſh, but the means of allaying the excited ſtate of the uterine

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rine ſyſtem, after the object is accompliſhed. It is not the diſcharge of a few ounces of blood which relieves the ſyſtem; for drawing blood ſimply will not do it; but it is the excited action of the uterine ſyſtem which relieves the general diſtreſs, and that topical action has full relief in the menſtrual diſcharge. General and topical plethora are terms which have been of great ſervice in explaining this periodical change in the female ſyſtem, but the ſtate of mere fullneſs, has little effect either on the conſtitutional or topical change. Even in the exhauſted and debilitated ſtate of the ſyſtem, when menſtruation ceaſes from the want of energy and power in the vaſcular ſyſtem, ſtill there remain the ſame laws governing the ſympathies, and relations of the ſeveral parts; and although they are feebly and imperfectly excited, they give riſe to accumulated diſtreſs at the period in which the menſes ſhould flow.

There is more general diſtreſs at puberty, and when the menſes firſt flow; but afterwards, when the periodical action and diſcharge is eſtabliſhed, there is little or no previous indiſpoſition.

With regard to vicarious hæmorrhagy from remote parts of the body, ſome, whoſe opinion I greatly value, do not conſider them as deviations of the menſes. At all events, from what I have ſeen of ſuch hæmorrhagies (tumors, for example, diſcharging blood at the menſtrual periods), I would obſerve, that there is an excitement, throbbing, and diſtenſion, previous to the diſcharge of blood, which confirms me in the notion of the neceſſity of a counter excitement and action, as well as the diſcharge of blood, being neceſſary to make a derivation from the uterine veſſels. It is by diſſection alone that we can form an eſtabliſhed opinion regarding the final uſe of the periodical return of the menſes.

By diſſection we come to the knowledge of the moſt eſſential facts. In the firſt place it is found, that the ovaria, and their veſſels, partaking of the general excitement of the ſpermatic arteries, are enlarged, full of blood, and with every ſign of increaſed action. We

find

find alſo, that the ovaria are matured and brought to pullulate, and almoſt to ſtart from their inveſting membranes. Again, when we attend to the womb, we find, that there are marks of its whole vaſcular ſyſtem being rouſed to action. It has become laxer in its texture, and there is a change ſimilar to what takes place in the firſt ſtage of pregnancy, but leſs in degree. The veſſels on the inner ſurface of the womb have been influenced by an action ſimilar to inflammation, and it is aſſerted, that even the decidua is ſometimes formed. Thus, while the ovaria are ripened to that degree of maturity, which prepares them for impregnation, the ſurface of the womb, and its whole vaſcular ſyſtem, is preſerved in a ſtate of preparation for the adheſion of the ovum, when it ſhall have deſcended through the Fallopean tube. I conclude that in conſidering this ſubject of menſtruation, the mere circumſtance of the diſcharge of blood has been too much attended to, while theſe other more eſſential circumſtances have been neglected. The end of this periodical change is to ripen the ovum, the flow of menſtrual blood to allay the excited ſtate of the uterine veſſels.

It is not eaſy to determine, ſays Haller, either in this, or in any other ſpontaneous hæmorrhagy, from what kind of veſſels the blood flows. From the circumſtance of the hæmorrhoidal diſcharge, which certainly is from veins, and from the lochia, which is generally ſuppoſed to be a diſcharge from the venous ſinuſes of the womb after delivery, we have the argument of analogy, that in menſtruation alſo it is a venous diſcharge. This opinion is further confirmed from ſtagnant blood being found in the uterine veins of women dying during the flow of the menſes, and orifices being obſerved larger than could well be ſuppoſed to be the extremities of arteries.

I would ſay, that it is little probable that ſpontaneous hæmorrhagy proceeds from the rupture of the extreme arteries, becauſe it is the activity of the arteries which cauſes the hæmorrhagy; and becauſe this activity is the exertion of a muſcular force, and the exertion of a muſcular fibre never is ſuch as to tear the fibre itſelf. On the other hand, we obſerve that it is the neceſſary conſequence of an increaſe of the action of arteries, that the

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correſponding veins dilate, and ſeem to ſuffer a force of diſtenſion proportioned to their increaſed activity. We muſt not forget that many are of opinion, that the menſtrual blood flows from the exhaling arteries. This opinion muſt reſt upon argument, and not facts, unleſs the aſſertion of Raauw be taken as proof, that he could diſtinguiſh their mouths ; or that of Mebomius, who ſaid he introduced briſtles into them. That anatomiſts have introduced briſtles into pores, or foramina, it would be ungracious to doubt, but that theſe were the orifices of exhaling arteries, is difficult to believe. I rather imagine, that there is a proviſion for this evacuation in pores, or foramina, in the extreme veins on the vaſcular inner ſurface of the womb.

From the conſideration of the cauſe of menſtruation, as I have conceived it, from the ſymtoms which proceed and accompany it, and from the effect attributable to the menſtrual action on the uterine ſyſtem, we cannot conſider it as a mere evacuation of blood, but rather as of the nature of a critical diſcharge relieving the ſymptoms which preceded it. With regard to the opinion of its being a ſecretion, we muſt firſt know accurately what is meant by the term. If thoſe who ſuppoſe the menſtrual blood a ſecretion, mean only that the blood is occaſionally changed by the action of the veſſels of the womb, I ſhould willingly acquieſce in their opinion ; for even during the bleeding from the arm by the lancet, or from a common wound, the blood is altered in the ſpace of the few minutes during which it flows ; and before the final ſtopping of a common hæmorrhagy, there is a change in the properties of the effuſed blood.

When there is an unuſual ſource of irritation in the womb, added to the natural and periodical excitement of the parts, the menſes became more profuſe, they laſt for a longer period, the time of their intermiſſion is ſhortened, and, in the end, from ſome diſeaſes of the womb, there is a perpetual oozing of blood, which debilitates the woman, and deſtroys her conſtitution, or there is ſudden and profuſe diſcharge with coagula, unlike the uſual evacuation.

OF THE CHANGE PRODUCED BY THE UNION OF THE SEXES.

In confidering thofe changes produced on the ovaria and womb by impregnation, we muft have recourfe to analogy in the firft inftance. By attending to the changes produced in vegetables, and the lower animals, we may be enabled to comprehend fome of the changes in the female organs confequent upon conception, and which we might not otherwife be enabled to underftand.

We fee that vegetables propagate their branches in every refpect like the parent trunk. We fee in the autumn the bud lodged in the axilla of the leaf, and obferve it pafs through the winter in a kind of dormant ftate; but when it is influenced by the returning heat of the fpring, it fhoots out to full maturity. This growth is a natural power of propagation, and increafe, marked by no very peculiar circumftance, yet bearing a ftrong analogy to the production of the feed.

In the formation of the fruit of the fame tree, we fee a more complicated provifion for the propagation of the plant. We find that although the feed appears to be formed by the natural growth of the part like the bud, yet before it becomes prolific, and capable of growing, and arriving at maturity, it muft be influenced by circumftances fimilar to the union of the fexes of animals; that its power of reproduction depends upon the reciprocal action betwixt the parts of the fame plant, or by the approximation of male and female plants.

Between the formation, maturity, and impregnation of the feed of plants, and thofe of the ova of animals, there is a clofe analogy. The feed is formed and matured while attached to the parent plant; but the veffels of the plant having completed this operation, fhrink from their connections with the feed, leaving it with its little fyftem of veffels complete, and with a kind of imperfect life, which may be confidered as analogous to a dormant ftate. This imperfect life, or perhaps a ftate merely capable of being excited into life and motion, continues for the winter feafon, or for a longer period.

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The flower of plants ſolicits the fluids to the ſeed, as the influence of the leaf cheriſhes the bud in the axilla. The pulp of the fruit is probably a proviſion of the ſame kind, or when it has fallen, to lay the foundation, by its decay, of a ſoil ſuited to the tender plant.

In the ſeed itſelf, we have much to admire. We find it incaſed in a ſtrong huſk, or ſhell, which is in general provided with a porous part ready to imbibe the moiſture of the ground. In the nut within the outer ſhell, there is a ſoft ſpongy ſubſtance, which, receiving the moiſture, ſwells and burſts up the ſhell, and relieves the ſeed. The kernel of the nut is then like a common ſeed, it has begun to vegetate, and theſe are the parts which form the ſyſtem of its œconomy. The principal part of the ſeed conſiſts of albuminous matter for the ſupply of the nouriſhment to the embryo plant, ſo as to prolong its ſhoots, and to ſend down its roots into the earth. The little embryo plant lies complete in all its parts, betwixt the lobes of albuminous matter, in a ſtate of torpor, or in which the operation of the living principle is ſuſpended. From the embryo plant there extends into the albuminous matter of the ſeed veſſels, or tubes, inactive, but ready on the ſupply of heat and moiſture, to abſorb the nutritious matter of the albumen, and miniſter to the increaſe of the embryo plant.

Now the root of the little plant ſprouts from the ſeed, and has a tendency to ſtrike into the ground, and the bud riſes to the ſurface towards the light, and the influence of the atmoſphere.

We ſee in this inſtance, that the operation of the ſyſtem of tubes of the embryo plant in the albumen was merely ſuſpended, that upon the ſeed being put into the ground, the heat and moiſture promote the germination, by driving the nutritious matter of the albuments to the embryo plant. In the firſt ſtage of this change, the matter abſorbed by the veſſels of the albumen ſupply that nouriſhment, which afterwards is conveyed from the root ſtriking into the earth, and from the leaves abſorbing from the atmoſphere. And when the roots have ſtruck into the earth, and the firſt leaves riſe upon

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the ſurface, the lobes of the albumen are exhauſted and fade, or riſe up in form of leaves, ſtill cheriſhing the tender plants.

When we come accurately to examine the ſituation of the embryo in oviparous animals, we ſhall find the ſame proviſion for the nouriſhment and growth of the young animals, independent of external circumſtances, nouriſhment prepared for it until it ſhall be enabled to gain ſtrength to feed itſelf.

The manner in which an egg is formed is this: The yolk, with its delicate membranes, are formed in the ovarium of the hen. The ovarium is placed on the backbone, innumerable yolks are ſeen gradually formed, and ſucceſſively increaſing in ſize. When they are matured, they are of the full ſize we ſee them in the perfect egg; they are ſurrounded with a delicate web of membranes, extremely vaſcular, the membrane of the yolk burſts when it is mature and impregnated, and then it falls into or is graſped by the infundibulum, or what anſwers to the Fallopian tubes in woman and quadrupeds. While yet in the egg-bed, the embryo is ſeen to be included in its membranes, upon the ſurface, or in the membrane of the yolk, it is called cicatricula; as the yolk, and the cicatricula, paſs through the uterus, the yolk, in a moſt curious way, has the addition of the other part of the egg. The uterus of a bird is not like that of other quadrupeds or vivaparous animals, ſimply for the reception of the ovum; but it is long and convoluted like the inteſtines. And the yolk, as it drops into the upper part of it, collects as it paſſes along the uterus, the white of the egg, which is a ſecretion from it. As it proceeds downwards, it receives the membranes of the white, and before it is excluded, it is coated with the ſhell to preſerve it from injury when it ſhall be dropt from the hen. In the fully formed and incubated egg this is the ſituation of the parts. Under the ſhell is a membrane which inveſts the whole parts, but leaves a ſpace containing air in the greater end betwixt it and the ſhell. Within this membrane the glarry white of the egg is contained, and within the white or albuminous matter is the yolk. Under the membrane

membrane of the yolk, there is a ſmall ſpot of a lighter yellow than the yolk. This, upon examination is found to be a veſicle, and within it we ſee a leſſer circle formed by an inner veſicle: this is cicatricula, and within this the rudiments of the chick are contained. We may obſerve, that the yolk is ſpecifically lighter than the white; again, it is fixed, towards the two extremities of the egg to the albumen, or white, by the chalaza. Theſe are like twiſted cords, which ariſe from the yolk, and expand in the white, ſo that they take a pretty firm hold on its tenacious ſubſtance. Theſe chalaza are not fixed to the yolk in its axis, but to the ſide, ſo that the buoyancy of the yolk keeps it revolving as the egg is turned, ſo as always to preſent the cicatricula to the upper part of the egg, in whatever way it is placed; conſequently it is always contiguous to the body of the hen, ſo as immediately to receive the influence of the maternal heat. By incubation, the principle of life in the chick and its membranes is rouſed, and the firſt perceptible change appears in little bloody ſtreaks, which, running together, form a circle of veſſels, and, which, are ſeen to terminate in the umbilicus of the chick.

This vaſcular circle, the moſt beautiful appearance of any in the œconomy of animals, ought to be particularly explained. In Mr. Hunter's book treating of the blood, there is a plate which repreſents the embryo of the chick in the incubated egg, at three different ſtages of its formation, beginning with the earlieſt viſible appearance of diſtinct organization.—The preparations from which theſe figures are taken, form part of a complete ſeries contained in Mr. Hunter's collection of comparative anatomy.—They are meant to illuſtrate two poſitions laid down in his work, viz. that the blood is formed before the veſſels, and when coagulated, the veſſels appear to riſe; that when new veſſels are produced in a part they are not always elongations from the original ones, but but veſſels newly formed, which afterwards open a communication with the original.

This to me ſeems an idea founded on a very limited view of the ſtate of the parts. We muſt recollect that this

this is not the formation of new parts or new veſſels. The embryo is in that ſtate of which I have endeavoured to convey an idea, by the term dormant; poſſeſſing that degree of life which is to be renewed by incubation, or artificial heat, but which will laſt a great length of time, and, like the germ in plants, be brought to vegetate only in particular circumſtances. The tract of theſe veſſels is laid in the original conformation of the embryo and ſurrounding membranes, they are now merely called into action, and we ſee only the effect of this action. We ſee red blood formed; we know that the redneſs of the blood is derived from the membranes, and matter which ſurround the embryo, and that it is conveyed to to the chick or embryo. Before we allow ourſelves to conjecture what is the firſt motion in the circle of actions which now take place, we muſt conſider whether it be not more likely that the firſt action of theſe veſſels is in abſorption; that is, an abſorption in the extremities of theſe veſſels, or is there firſt, an action of the heart of the chick? — We are left to this queſtion. Is it probable that a change ſhall take place in the fluids which ſhall ſtimulate the veſſels? or ſhall the heat of incubation ſtimulate the veſſels to act upon the contained fluids? or, as ſeems moſt probable, does the incubation, at the ſame time, produce a change in the fluids, and ſtimulate the veſſels to action? To explain what I ſhould rather conceive to take place, I ſhall deſcribe the probable ſeries of actions.

In common ſeed, the ſmall germ of the plant has its veſſels paſſing out into the lobes of the albumen to abſorb the food, upon the exiſtence of the peculiar circumſtances neceſſary to its being ſtimulated to activity and growth. We have to obſerve, that where the nut was attached in its huſk to the tree, it has left a porous part; by this cribriform kind of plate the moiſture of the earth enters;—that dry ſcurfy ſubſtance which we obſerve on the inſide of the ſhell, ſwells with the moiſture which alſo penetrates the albumen or kernel—the moiſture forming a combination with the albumen prepares it for abſorption; the veſſels are at the ſame time excited, abſorb, and

and thus nutritious fluids are conveyed to the germ—the nut splits by the swelling of the parts, and the corculum or bud sprouts up.—We find then, that in this instance the grain, or nut, is brought into action by the fluids absorbed, forming new combinations with the albumen or kernel, and the active exertion of the living powers, beginning by an operation in the fluids.

In the same manner, I conceive, that the incubation of the egg causes an action first in the fluids, not in the solids (for these are solids according to the strictest signification of the term; and strong membranes, as a little vinegar will show, when poured upon the albuminous substance of the egg). A change takes place in the fluids, there are new arrangements suiting them for absorption, by those circles of vessels which are laid on the original formation of the membrane. The fluids act as a stimulus to those vessels, whose alternate action and relaxation never cease until the termination of life. I conceive this explanation, which I have offered, to be more consonant with the great principles of physiology, and an extensive analogy of similar actions in the œconomy, than that explanation of Mr. Hunter, which supposes the specks seen at the sides of the vessels, to be spots of coagulated blood, destined afterwards to become blood vessels. For, I am apt to conceive, the red blood to be formed only after several rounds of the circulation, and to depend upon a more perfect assimulation than that first excited: and that Mr. Hunter is all along in this mistake, that he is supposing these vessels to be newly formed, which are laid in the constitution of the membranes surrounding the embryo, and which are now only called into action, and only become apparent when they convey red blood.

In the system of the egg there are other circumstances worthy of notice: as the chick grows by the absorption of the white, or albumen, the new combinations reduce to a lesser bulk the whole mass, which is within the shell, and now we perceive the use of the air-cell, which enlarging, fills up this space. When the chick has escaped from the shell, the yolk of the egg is not exhausted,

ed, but it is found to be received into the belly of the chicken, and to have a conduit leading into the duodenum, by which it is poured into the inteftinal canal. It is for fome time a fource of fupply to the young animal until its ftrength is equal to the digeftion of its appropriate food. And in this refpect it is analogous to the fuckling of viviparous animals.

Let us now obferve what analogy exifts betwixt the generation, or rather the birth and nourifhment of the embryo of the viviparous animal, and thofe of the oviparous. As to the precife effect which the approach of the male has upon the ovarium of the female, whether by this union of the fexes, there is an actual addition to the ovum, or only an influence exerted on the parts already there, by the prefence of the male femen, it feems almoft needlefs to hope for an abfolute decifion.

The refemblance of the offspring to both parents, would influence us at once to conclude, that there muft be a union of the parts from both fexes. But when we confider how much the peculiarities of individual animals depend upon certain peculiarities of action; how the conftitutional predifpofitions muft depend on the fame peculiarity in the action of the veffels, fince the doctrine of abforption teaches us, that of actual fubftance nothing is permanent, but all fuffers an inceffant revolution and change, we are forced to conclude that nothing can remain but certain peculiarities of action, and we may then come to allow, that the male femen merely influences the ftate of the parts already formed, and does not beftow an actual fubftance.

In the fpeculations on the fubject of generation, facts and obfervations have been fo very rarely attended to, that thofe which have been offered feem to have had a preponderance much beyond their real value. Thus the microfcopical demonftration of animalculæ fwimming in the femen of the male, has given birth to an idea that they were homunculi, which being introduced into the proper nidus of the female, grew up to man's eftate. Though, where all is conjecture, and, perhaps, as no

 better

better explanation is to be offered, it may ſeem improper ſo directly to contradict any theory, ſtill I muſt ſay, that this is, in my mind, the height of abſurdity. To ſuppoſe an animal ſecreted along with the ſeminal fluid from the teſticle of the male (and which in all probability, is the production of ſtagnation and putridity), to ſwim and be nouriſhed in the male ſemen, and yet to hold that on being introduced into the ovaria, it changes from an active animal into an impalpable gelatinous-like maſs, and, after a ſeries of changes, grows at laſt to the maturity of a human being, is altogether beyond my comprehenſion.

The experiments made by the ingenious Dr. Heighton, throw conſiderable light upon theſe deluſive ſpeculations regarding the impregnation of the female. He found by experiments on rabbits, that upon cutting the Fallopian tubes, forty-eight hours after the coitus, the impregnation was equally obſtructed as when he had cut them previous to admitting the male ; it would appear that in theſe animals impregnation is by no means the inſtantaneous effect of the union of the male and female, but that it requires at leaſt fifty hours; for, when Dr. Heighton cut the Fallopian tubes at that period, it did not prevent impregnation. Dr. Heighton proves, that the generative proceſs is not an inſtantaneous effect, as we ſhould very naturally ſuppoſe, but an operation requiring time. That the ſemen does not reach the ovaria during, or immediately after the coitus, is ſufficiently evident; and it is ſtill more ſo, that the ovum is impregnated while in the ovarium, and not upon its deſcent into the womb, which is proved from the fœtus ſometimes remaining in the ovarium, or tubes, and growing to maturity. Dr. Heighton ſuppoſes the ſemen only to affect the vagina and uterus, and that a conſent of parts, or ſympathy, is communicated along the tubes and ovary to the ovum ; and that neither the ſemen, nor the aura ſeminalis reaches the ovaria. When we look abroad for analogies, however, and find the ſemen of ſome animals, as fiſhes, merely thrown out upon the

already evacuated ſpawn, we cannot readily acquieſce in this opinion of the mere ſympathy of the female parts calling the young animal into life.

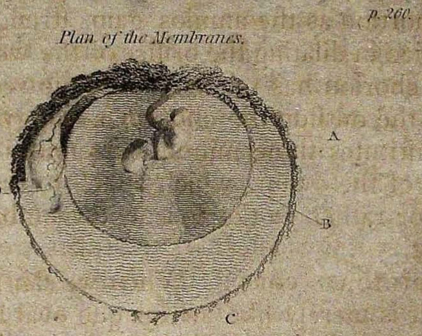
Leaving this ſubject, we have to obſerve, that previous to impregnation there is a ripeneſs and prominence of ſome of the ova, that by coition the Fallopian tubes do not inſtantly graſp, impregnate, and cauſe the burſting of the ovum from the ovarium ; but there is an action commenced which gradually brings about this change. Whilſt the ovary is thus affected, the tubes are preparing for their action of embracing the ovum, there is an increaſed turgeſcence in their veſſels, and an enlargement and ſwelling of the fimbriated extremity. When thus prepared, it approaches the ovarium, graſps, and receives the ovum, and by a periſtaltic motion, probably very ſlow and gradual, the ovum is conveyed into the cavity of the uterus.

OF THE OVUM, AND ITS CONNECTIONS WITH THE UTERUS IN THE EARLY MONTHS OF PREGNANCY.

THE ovum, when it has deſcended into the uterus, and is perfect in its ſtructure, is a ſoft oval maſs, fringed with veſſels, and compoſed of membranes containing the early fœtus. When opened, or diſſected, it preſents three cavities, or we obſerve the fœtus to be ſurrounded with three diſtinct membranes. The 1. Decidua, or tunica filamentoſa, falſe chorion, or ſpongy chorion. 2. The chorion. 3. The amnios. Of theſe coats, the outer one is formed by the womb, the others conſtitute the ovum as it has deſcended from the ovarium. We ſhall, in the firſt place, attend to the original membranes and general conſtitution of the ovum, and then to the deciduous covering which it receives in the womb *.

* See Albin. Ann. Acad. lib. i . cap. xviii. and xix. Hunter's tables of the Gravid Uterus.—Camper Icones.

Plan of the Membranes.



A, The Fœtus. B, The Amnios. C, The Chorion. D, The Veſicula Alba.

Amnion. The amnion is the veſicle which immediately involves the fœtus. It is a very thin and pellucid membrane in the early ſtage of pregnancy, but it acquires conſiderable thickneſs and ſtrength in the latter months.

The aminion contains a thin watery fluid in which the fœtus is ſuſpended. In the abortion of the early months, we find the quantity of this fluid very great in proportion to the whole ovum, and this forms a defence to the delicate and almoſt gelatinous ſubſtance of the fœtus, while it is a proviſion alſo for the regular preſentation of the head of the child, for now the fœtus being ſuſpended in this fluid, and hanging by the umbilicus, and the head and upper part of the body greatly preponderating, it takes that poſition with the head preſenting to the orifice of the womb which is neceſſary to natural and ſafe labour, the fœtus being prevented from ſhifting in the latter months by the cloſer embracing of the child by the uterus.

Chorion. The chorion is the ſecond involving membrane of the fœtus; on the inſide it is ſmooth, and betwixt it and the amnion a gelatinous fluid is interpoſed. In the early months it is much ſtronger than the

the amnios, but in the advanced ſtage it has come in contact with the amnios, no fluid being betwixt them. And in proportion as the amnios gains ſtrength to be of eſſential ſervice in dilating the orifice of the womb during labour, the chorion has relatively become very thin and weak. On the outſide the chorion is ſhaggy and vaſcular, and conſtitutes thoſe minute extremities of the vaſcular ſyſtem of the ovum, which attach to the ſurface of the womb, or rather to the flocculent membrane which it throws out.

THE UMBILICAL CORD. When we can firſt diſcern the fœtus, it is merely like an opaque oval body of the ſize of a common fly, and cloſely attached to the amnion; but, by degrees, it recedes from it, and then we perceive that it is attached by the umbilical cord, which conſiſts of the trunk of the veſſels going out from the fœtus, and which diſtributed upon the chorion receive the ſupplies from the maternal ſyſtem.

Now we perceive that the fœtal ſyſtem which deſcends from the ovarium, is not merely a fœtus or embryo, but that this embryo, beſides a ſyſtem of veſſels within its own body, is ſurrounded completely with membranes, and that from the vaſcular ſyſtem of the embryo, there go out veſſels, which being minutely diſtributed to the outer veſicle, or membrane, and actuated by the ſame heart which circulates the blood through it, our little corporeal ſyſtem prepares for imbibing the due nouriſhment from the uterus.

VESICULA ALBA. The veſicula alba, or umbilicalis, is a little veſicle which lies betwixt the chorion and amnion; it contains a white fluid; it is connected with the naval or cord, by an artery and vein. Very little has been offered as explanatory of its uſe, it has been conſidered as ſimilar to the alantois of quadrupeds, and having a connection with the urachus; but it has no communication with the bladder, and ſoon diſappears. Whereas, if it had been for receiving the ſecretion of urine, it would have been prepared for the more mature ſtate of the fœtus.

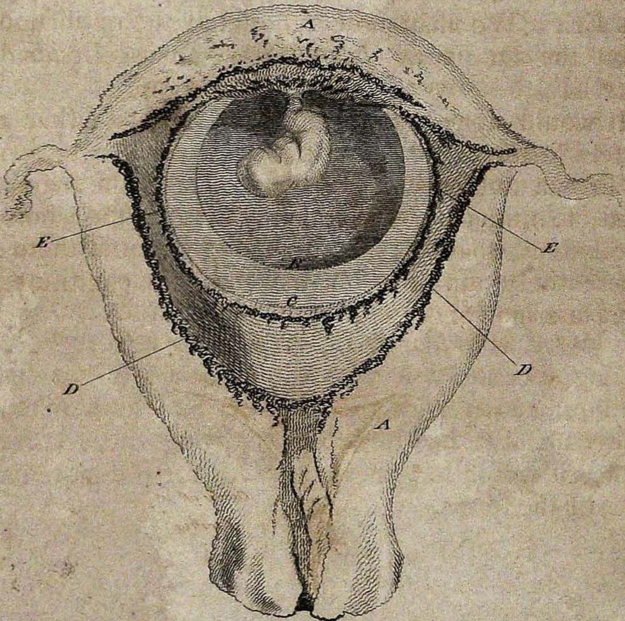
I con-

I conceive it not to be improbable, that it is a provision of ſupply for the embryo, previous to its perfect attachment to the uterine ſyſtem, and during its deſcent into the womb, perhaps ſimilar to the albumen of oviparous animals, but which, after the perfect eſtabliſhment of the connection betwixt the fœtal and maternal ſyſtem, ſhrinks and diſappears, as being no longer neceſſary.

OF THE ADDITIONAL MEMBRANES WHICH THE OVUM RECEIVES FROM THE UTERUS.

WHILE the ovum is taking the changes conſequent upon impregnation, the womb partaking of the general ſympathy which prevails over the whole uterine ſyſtem, ſuffers a change adopting it for the reception of the ovum. The firſt appearance of action in the womb is marked by a greater activity of the veſſels, a ſwelling and ſoftneſs of its ſubſtance. While on the inner ſurface there is an exudation which, being converted into a ſpongy membane, is peculiarly adapted for the reception and adheſion of the ragged and vaſcular ſurface of the ovum.

p. 263.



In

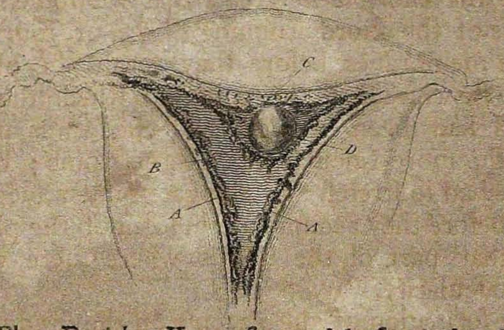
In this plan we ſhall be able to obſerve the relations and inflections of the uterine membranes or decidua, as ſeen and deſcribed by Dr. Hunter, and of their correctneſs, my obſervations in diſſection leave no doubt in my mind. AA, the uterus in out-line; B, the amnion with the fœtus; C, the chorion. Now it is obſerved, upon a careful examination of an abortion of the early months, that beſides the chorion and amnion, there is a ſpongy membrane of two diſtinct laminæ which inveſts the chorion. The outermoſt of theſe is found to ſurround the whole ovum, even inveſting that part which has become the placenta by the accumulation of veſſels. This outer membrane then may be repreſented by the line DD. It is repreſented as adhering to the ſurface of the womb, as it muſt do in fact. We obſerve again, that it is perforated where the Fallopian tube enters the womb, that at this part it is not formed; ſo that, according to Dr. Hunter, and the preparations which I poſſeſs, theſe tubes open into its inſide.

Upon diſſecting up the outer lamina of the decidua, we find that where the placenta commences, it is reflected over the ſurface of the ovum and the ſhaggy chorion of the ovum, ſo as to be repreſented by the letters EE. We ſhall now underſtand the diſtinction betwixt the DECIDUA VERA DD, and the *Decidua Reflexa* EE.

It would appear that this membrane is either completely formed, or at leaſt the fluid which is to form it, is thrown out previous to the deſcent of the ovum; indeed, ſo intimate is the ſympathy betwixt the whole uterine ſyſtem, that this membrane is formed in thoſe caſes where the ovum does not deſcend, but conſtitutes the extra uterine conception.

Dr. Hunter ſuppoſed, that the ovum paſſed into the cavity of the uterus whilſt the coagulable lymph was pouring out by the arteries of the uterus, and that it was thus immerſed in and ſurrounded by the decidua, for he could not conceive that it could gain admiſſion betwixt the lamina of the membrane already formed.

The only other ſuppoſition is, that the ovum A, upon its deſcent gets intangled behind the deciduous membrane B, by which means the ovum is not left looſe in the cavity of the womb, but it is ſoon attached and ſurrounded with a membrane, or vaſcular web, from which it can immediately draw ſupplies, and by this proviſion alſo its adheſion to the ſuperior part of the uterus is inſured. But as the ſame action of the uterus continues, and, as we muſt naturally ſuppoſe, be rather occaſioned by the preſence of the ovum in its cavity, the ſurface of the uterus at A continues to throw out a coagulable matter which ſurrounds that part of the ovum, ſo that this will immediately become its ſituation.



A, The *Decidua Vera*, formed before the deſcent of the ovum. B, the *Decidua Reflexa*, formed by the ovum getting behind it and puſhing it down. C, the efflorescence which continued to be poured out, ſurrounds the upper part of the ovum, and which, from its more immediate ſupply from the uterus, will in time form the ſole ſupport of the fœtus, viz. the uterine portion of the placenta.

OF

OF THE PLACENTA, AND OF THE NUTRITION OF THE FŒTUS.

When the ovum firſt deſcends into the uterus, the fleecy ſurface of the chorion eſtabliſhes a univerſal adheſion, but no ſooner is the attachment of the ovum eſtabliſhed, than the veſſels of the fœtus which are univerſally diſtributed over its ſurface, begin to accumulate to that point from which the more abundant ſupply is obtained. Thus, from the univerſal adheſion the veſſels of the fœtus are maſſed and accumulated together, ſo as to form a thick cake or placenta. This takes place upon the ſame principle that the roots of a plant ſtretch towards the ſoil beſt ſuited to it, or the branches and leaves of a plant grow and ſpread towards the light. The placenta is deſtined to adhere to the fundus of the womb, and there we obſerve the accumulation of the large veſſels of the womb, it being equidiſtant from the ſeveral ſources of blood; and to this point is the tendency of the veſſels of the chorion ſo great, that we ſometimes ſee the veſſels of the chord running three or four inches upon the membranes before they reach the placenta, evidently ſhewing that the point to which the umbilical cord had been originally attached, was not oppoſite to the more vaſcular part of the womb; but that the veſſels had to ſtretch and elongate ſome way from the inſertion before they accumulate in form of the placenta, towards that part of the uterus where there was the greateſt vaſcularity.

But the formation of the placenta on the fundus of the womb is not conſtant, although there are many proviſions for enſuring attachment there. But when it does form low in the womb, or on the orifice itſelf, we then perceive the reaſon of nature's ſolicitous care in preventing it; for it occaſions the moſt dangerous floodings from the placenta preſenting on the approach of labour, and its connections being neceſſarily torn up previous to the delivery of the child.

The

The placenta of the advanced ſtage of geſtation is a maſs formed partly by the accumulations of the veſſels of the fœtus (the trunk of which is the umbilical cord), and partly of a vaſcular and cellular portion formed by the uterus. On the ſurface attached to the womb, the placenta exhibits deep and irregular fiſſures which divide it into lobes; but on the inner ſurface is ſmooth from the inveſting membranes, but raiſed into irregularities by the numerous and tortuous ramifications of the umbilical veſſels. When rudely torn or cut into, it appears to be a ſpongy ſubſtance, formed in a great part of an irregular tiſſue of veſſels.

In the human ſubject we find, that the maternal part of the placenta is thrown off with the other ſecundines, and does not ſeparate from the fœtal part of it. While, in other viviparous animals, the monkey excepted, the filamentous extremities of the fœtal veſſels ſeparate from the glandular maſs formed by the maternal veſſels of the uterus.

The placentary veſſels of the fœtus never touch the ſurface of the womb, but communicate with the maternal ſyſtem through the veſſels of the womb, which pierce the deciduous membrane. Still the queſtion of the preciſe manner in which the veſſels of the fœtus communicate with thoſe of the mother remains undetermined. I conceive that in the early ſtage the deciduous membrane being thrown out by the action of the uterine veſſels, thoſe of the chorion ſtretch into it, and abſorb the nouriſhment. The decidua is a vaſcular membrane, but it has, at the ſame time, a peculiar ſpongy texture. This ſpongy, or reticulated ſtructure of lamina of the decidua ceaſes where the placenta is affixed. When we carefully diſſect up the decidua to the margin of the placenta, it is found to be more rigid, white, firm, and thick *. When we examine the outſide of an entire ovum, we obſerve that at the place covering the placenta, it is corrugated and full of irregular eminences like the con-

* I ſpeak after diſſecting the ovum of the third month.

volutions

volutions of the brain, and amongſt thoſe irregularities many ſmall convoluted arteries may be diſcerned, with ſpots of extravaſation and the flat mouths of veins. Upon diſſecting up this maternal part of the placenta, we find it to form the firmeſt part of it; and by the difference of colour, as well as by the poſſibility of tearing it up, or diſſecting from the maſs of veſſels of the chorion, we recognize it as the decidua. This union, however, betwixt the maternal and fœtal parts of the placentia is intimate, and it is impoſſible to determine by diſſection with the knife, whether there be inoſculations betwixt the maternal and fœtal veſſels, or whether the nouriſhment of the fœtus is by abſorption, nor can we diſtinguiſh in the firſt months the cellular intertexture which may be obſerved in the placenta of the full time, as deſcribed by Mr. Hunter.

In explanation of this part of our ſubject, I have purpoſely diſſected, and made drawings of the ovum in ſeveral ſtages. This point of anatomy relating to the decidua, is particularly explained in Plates VI. and VII. to which I refer the reader.

OF THE LIQUOR AMNII, AS CONDUCING TO THE NOURISHMENT OF THE FŒTUS.

Some phiſiologiſts obſerving the ſtrict analogy which exiſts between the function of the placenta and the lungs of breathing animals have conceived, that the liquor amnii is the ſource of nouriſhment, and that it is taken into the ſtomach. I believe they have conceived ſome analogy to exiſt betwixt the albumen of the egg and the liquor amnii, which in their minds has ſtrengthened this opinion. But there is here no analogy; we have ſeen, that the embryo of oviparous animals being formed with the yolk in the egg-bed or ovarium, deſcends into the uterus, and there receives the addition of the albumen or white. On the other hand, we find that the ovum of viviparous animals is formed in the ovarium; and that the liquor amnii being within the membranes of the ovum, muſt be the production of the fœtal ſyſtem.

Further,

Further, when the ovum has descended into the womb, and grown to some maturity, we see that there is no connection by vessels betwixt the fœtus and mother but through the placenta; that the liquor amnii is within the involving membranes of the fœtus, and that consequently it must be thrown out by the vessels of the fœtal system. Thus, to suppose the fœtus to be fed by the liquor amnii, would be to suppose it to draw resources from its own system, and that the vessels poured out a fluid, which is afterwards to be taken into the stomach *. But without adducing arguments, it is sufficient to say, that fœtuses have been brought forth, monstrous in their conformation, and without mouths yet well grown.

Of the placenta as the source of nourishment to the fœtus. When we consider the mere speck of the embryo in the first weeks, we see that it can have no other source of nourishment than through the extreme vessels of the chorion, connected with the short umbilical cord; and we may be convinced also, that in its progress to maturity, when the general connections of the chorion cease, and the placenta is formed, the sole supply is through its vessels. Regarding the manner of the communication betwixt the vessels of the mother and child there are many opinions. The simplest explanation, but the furthest from the truth is, that the arteries of the womb are continued into the veins of the fœtal portion of the placenta. That on the other hand, the arteries of the fœtal system are continued into or inosculate with the veins of the womb; and that thus, the blood of the mother's system is carried by direct inosculation. A little investigation will convince us, that this is a very unlikely conjecture. We see the embryo surrounded with its vessels, and forming a complete system within itself, descend into the womb. We see that the attachment betwixt the surface of the ovum and the womb, depends on a reciprocal action betwixt them; and

* A greater absurdity than that of which a foreign author is guilty cannot be imagined, because the liquor amnii, or some fluid, is found in the trachea, he supposes that the fœtus respires, and receives oxygenation from the liquor amnii.

when

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when the fœtus is feeble, or diſeaſed, or when it dies, the uterus immediately ſeparates from it, as from a dead part, and there is an abortion. Again, it is not natural to ſuppoſe, that the circulating fluids of the adult are calculated for the circulation in the embryo, or that the blood of the adult is fit for the circulation of the fœtus. When we inject the veſſels of the fœtus, we find the veins and arteries of the umbilical cord to inoſculate freely with each other, and the fluid paſſes from the arteries to the veins with little extravaſation or eſcape of fluid, and ſuch only as may be ſuppoſed to paſs from torn veſſels. Again, the bleeding of the child does not draw from the maternal ſyſtem; for example, when the accoucheur has to perform the operation of embrioulcio, and when the arteries of the brain pour out their blood, the woman does not ſuffer, nor is there any danger of hærmorrhagy from the cord after the delivery of the child. Again, what does the analogy of other animals ſhow us? We may obſerve, in the firſt place, that probably on account of the peculiar form of the womb of woman, and in theſe circumſtances to guard her from danger of hæmorrhagy during delivery, it is neceſſary that the placenta ſhould be accumulated towards the fundus of the womb. Now, to allow leſs danger of the ſeparation of the ſecundines from the womb, and conſequent abortion, there follows a neceſſity for the human placenta being attached in a particular manner; and in place of the maternal part of the placenta remaining with the womb, as in other animals, the whole maſs ſeparates on the delivery of the child. The neceſſity for this firmer attachment of the human placenta, cauſes the connection betwixt the fœtal and the maternal portions to be very intimate, and the manner of the vaſcular connection by no means eaſily demonſtrated.

In other animals, however, for example in thoſe which have the ſmall and numerous placenta, or cotyledons, the fœtal and maternal portions of the placenta ſeparate eaſily; the maternal part being a prominent vaſcular bed, which is a part of the womb, and is not deciduous. Here we find, that the glandular-like portion which belongs

longs to the womb may be minutely injected, and no particle of colour pass into the fœtal part; aud again injection shows the fœtal portion to be merely composed of the fleecy extremities of vessels, which, however, minutely injected, do not show any inosculations with the maternal vessels; in short, here the connection betwixt the extremities of the two systems is so very loose, and the filaments so minute, and almost like an impalpable mucus, that we can imagine no other kind of connection than that the extremities of the umbilical vessels take up by absorption the nutritious matter necessary for the system of the child, and that this is secreted by the vessels of the womb.

Investigation in every department of natural history shows a similarity, and a simplicity in the operations of nature. Comparative anatomy may be brought with much advantage in illustration of the very obscure laws which guide the functions of the parts of generation. When we turn our attention to the egg, we find, in the first place, that the vascular system is complete within itself, and requires no permanent connection with the maternal system to invigorate its action. We find that the artery which passes out of the umbilical cord of the chick, and which is distributed to the membranes of the white, pulsates strongly, and carries venous coloured blood. We find the returning vein carrying arterial coloured blood. We find then that these vessels must have a double function, they imbibe the nourishment from the white, and convey it to the increase of the chick; and they at the same time perform an action similar to that of the pulmonary vessels of the adult, seeing that they carry out dark coloured blood, and convey it back to the chick, of a bright vermilion colour. Now, I do not conceive, that this change upon the blood is performed by the communication of the atmosphere through the shell, for I see no distinction in the colour of the vessels, which are contiguous to the membrane of the shell, and those which are removed from it by the expanding of the air-cell. Further we find, that there is an intermediate kind of generation in fishes which are oviparous, but retain the egg within their womb, until the fœtus is matured;

matured; here no communication with the air or water can be allowed.

Since we fee that the chick in ovo is capable of miniftering in every effential particular to its own increafe, wherefore fhould we fuppofe that the fœtus of viviparous animals has any other more particular connection with the womb of the mother? — The difference is in my mind this fimply; the ovum of the oviparous animals defcending through the convoluted and inteftinal-like womb of the hen, accumulates a quantity of matter around it, which ferves every purpofe of nutrition when the embryo fhall be finally feparated from the maternal fyftem; but in the viviparous animals the ovum defcending into the womb remains there, and has an inceffant fupply of nutritious fluid, fecreted from the veffels of the womb, as it is required by the appetency of the fœtal fyftem. As in the egg, the membranes furrounding the white have the fame effect upon the blood, which is afterwards produced by the lungs; fo has the placenta of viviparous animals the double function of fupplying nourifhment, and the oxigenation of their blood. The umbilical vein carries back pure arterial blood, and the common opinion is, that the blood of the fœtus coming in contact with the blood of the maternal fyftem, receives the principle from it, which beftows this quantity of colour, with other neceffary qualities, of which this of colour is but the fign to our obfervation; or we may fay that the carbon of the fœtal blood is imbibed by the maternal blood; and in this way the blood of the fœtus is purified. It is not neceffary to this change on the fœtal blood, that it fhould come in immediate contact with the maternal blood, for it is poffible, that the matter thrown out by the maternal veffels, whilft it is nutritious, has alfo in it, in a condenfed, and not a gafeous form, that which is effential to the change of the blood of the fœtus from the modena colour to bright vermilion.

OF THE EXTRA UTERINE CONCEPTION.

We find fome curious facts relating to the action and fympathy amongft the parts of generation, proved by the cafes

cafes of extra uterine conception, where nature, baulked and interrupted in her ufual courfe of operation, fhows unufual refources. It wouldappear, that the ovum, after impregnation, has in fome cafes remained attached to its original feat in the ovarium, perhaps owing to fome want of due fympathy and fynchronous action of the Fallopian tubes, which fhould grafp and receive the ovum. In other inftances the ovum has been received into the Fallopian tubes, but either from a want of fufficient dilatation and action in them, they have not been able to propel it forward, or the ovum taking upon it that action which is deftined to form its connections with the uterus, adheres, and is enlarged in the tube, fo that it cannot be conveyed down into the womb.

I am not fo fully fatisfied of that kind of extra uterine conception, where after impregnation the ovum has dropt from the ovarium, and lies in the cavity of the abdomen amongft the vifcera. Here it is fuppofed the veffels of the fleecy chorion fpread, and attach themfelves to the furface of the vifcera.

Thefe inftances of deviation from the natural action of the parts after conception prove to us, I think, that from the moment of impregnation there is a principle of life and activity in the fyftem of veffels of the ovum, and that at a ftated period this action becomes fuch, that the efflorefcent veffels of the furface of the ovum attach themfelves to whatever vafcular furface they are in contact with. Further, it feems to fhow, that in the womb, and in the deciduous membrane which it prepares for the reception of the ovum, there is nothing very particularly neceffary, and that any vafcular furface will take upon it the fame changes, and being excited probably to fome peculiarity of action, will in every thing effential fupply the growth and nourifhment of the ovum and fœtus.

It fhows us how far the action previous and confequent to impregnation is a univerfal and fympathetic excitement of the uterine fyftem; that the decidua is formed in the cavity of the womb, although the ovum does not defcend. This points out to us how careful nature is, that there fhall be a reciprocal action in the ovum and womb, fo as to enfure the adhefion of the ovum, and

the ready ſupply of a proper nidus for it, when it ſhall have deſcended into the cavity of the womb. It informs us, that the uterus is a ſpongy and vaſcular bed, having peculiar ſympathies which actuate its veſſels, and a form of veſſels adapted to quick acceleration of action ſo as to grow, enlarge, and ſupply the ſecundines with nouriſhment.

It is not, however, in the mere adheſion and ſupply afforded to the fœtus, that the peculiar adaptation of the womb for the reception of the fœtus is ſhown, but in the proviſion for the delivery of the child at a regular and ſtated period. For, it is a curious fact, that in the caſe of extra-uterine fœtus on the expiration of the nine months, the uterus takes upon it that action, and that excitement of its muſcularity which is deſtined to expel the fœtus. We find, that at the uſual time of utero-geſtation, there are pains excited, and flooding, with the diſcharge of the decidua from the womb, although it contains no fœtus.

Nay, further it would appear from the reſult of ſeveral caſes, that at the expiration of the natural term of utero-geſtation, the fœtus indicates that it is governed by preſcribed laws, which render a change neceſſary, and ſhow that its ſyſtem is no longer fit to be ſupplied through the placentary veſſels, and as in the ſituation of extra-uterine fœtus this change cannot take place, it dies and becomes with its ſecundines, as a load of foreign or dead matter in the belly. This event is generally followed by the death of the mother, though ſometimes an abſceſs has opened and diſcharged the fœtus, or after much ſuffering, the bones have been diſcharged by ſtool, at long intervals.

OF THE WOMB AT THE FULL PERIOD OF GESTATION, AND OF DELIVERY.

To complete this view of the female parts of generation, it remains only to ſpeak of the ſtate of the parts at the full term of nine months, and to obſerve the proceſs of a natural delivery.

 The

The rapid increaſe of ſize of the pregnant womb in the ſhort ſpace of nine months, is perhaps the moſt ſurpriſing phenomenon of the whole animal œconomy; it ſhows the power of a peculiar excitement in calling into action a partial and local ſyſtem of veſſels. This ſtate of pregnancy is the furtheſt from a ſtate of diſtention, inſomuch, that it is obſerved the womb feels peculiarly ſoft on impregnation, and as if but imperfectly filled by the ovum. This ſoft ſtate is a ſign of vaſcular action. We may often obſerve in the diſcuſſion of a tumor, that before any change takes place, it ſwells and becomes ſoft, and this even where the tumor is about to be abſorbed.

The fundus of the uterus is the part firſt enlarged; and afterwards the inferior parts; at length the cervix is obliterated, and the uterus, which was originally pyriform, becomes nearly oval, and the diſtention, as we have remarked, is greateſt on the back part of the womb. In the firſt months the uterus ſinks lower in the pelvis, they ſay from its weight, but the ſpecific weight of the uterus is not increaſed, and on that account it ſhould not ſink deeper; it is, perhaps, rather from its enlargement, and the difficulty with which the fundus makes its way among the viſcera in the brim of the pelvis. Having deſcended conſiderably, the os tincæ projects further into the vagina, but the fundus continuing to enlarge, at laſt emerges from the circle of the bones, and then from the conical form of the uterus, it ſometimes riſes ſuddenly out of the pelvis; now the vagina will be found elongated, and the os tincæ removed from the point of the finger.

Now the ligaments of the womb direct it forward, and it riſes cloſe upon the abdominal paries, and before the bowels; in the firſt pregnancy it riſes almoſt directly up; in ſubſequent pregnancies from the greater relaxation of the integuments and the abdominal muſcles, it is allowed to fall more forward; about the fourth month of pregnancy, the womb may be felt in the abdomen, and riſing out of the pelvis; in the fifth month the fundus is about half-way betwixt the pubes and navel; in the

ſeventh,

ſeventh, it is about half-way betwixt the navel and ſcorbiculus cordis; in the eighth, it is at its higheſt, and towards the end of the ninth month, it rather ſubſides. Finally, immediately before labour it deſcends remarkably, and ſhifts into the middle of the pelvis, ſo as fairly to preſent the orifice of the womb.

The muſcularity of the uterus is increaſing from the firſt moment of pregnancy. As the uterus increaſes in thickneſs and is diſtended, the muſcular fibres become more diſtinct, and their power of contraction greater; but what is very particular is the great muſcular efforts made by the womb during labour by theſe fibres, which have not till that time felt the ſtimulus to action, or been allowed to contract.

When the period for the approach of labour is arrived, the nature of that viſcid ſecretion which ſeals up the orifice of the womb is altered, it loſes its viſcidity, and all the parts are relaxed and prepared for the tranſmiſſion of the head; even thoſe rigidities, ſtrictures, or calloſities of whatever kind, which would ſeem to promiſe an abſolute obſtruction to the paſſage of the child, yield and relax previous to labour. The action of the womb is at firſt feeble, as might be expected, and accoucheurs have marked theſe ſtages of a natural labour.

1ſt. The womb has ſuffered no diminution of its ſize; the membranes are entire, and, of courſe, the contractions of the womb are feeble, becauſe before it is allowed to make ſome contraction its efforts are not ſtrong. This is a proviſion for the firſt ſtage of labour being ſlow; by and by the orifice dilating, the membranes with the waters are felt protruding. The membranes and water is as a ſoft conical cuſhion, gently dilating the paſſage; and in this ſtage there ſhould be no officious interference. While the membranes are entire, both the mother and child are in perfect ſafety.

2d. The orifice continuing to dilate, and the efforts of the womb increaſing, the membranes burſt, and the head of the child preſſes on the orifice; then the womb

is allowed to contract: this contraction is a ſtimulus to greater efforts, and in a few pains, the head deſcends into the cavity of the pelvis. The orifice is completely retracted, and there is no longer a mark of diviſion betwixt the womb and the vagina; they are as one canal. If, however, the membranes are burſt too early the labour is not accelerated, but retarded. The orifice is not dilated by the ſoft and elaſtic membranes; the head of the child preſſes broad on the orifice, which becomes rigid, and perhaps inflamed, its dilatation is ſlow, and the labour tedious. Though from the form of the bones and particularly by the retiring of the ſacrum, there is a proviſion and guard for the ſoft parts of the mother againſt compreſſion by the head; yet nature intends this ſtage to be ſhort, for it is the period of danger. There is now obſtruction of urine and fæces, and the veſſels of the parts ſuffer compreſſion.

3d. Now the head of the child preſenting at the orifice of the vagina, forms a third ſtage; it is the ſtage of moſt exquiſite ſuffering: the head is puſhed forward during every pain, and recedes again in the abſence of pain. An interval of reſt precedes this ſtage, at laſt the pains return, and the hard head of the child coming to preſs on the orifice, and the womb coming in cloſe contact with the body of the child, the pains are redoubled in ſtrength. The face of the woman, perhaps, before pale and flat, becomes red and turgid, the eyes gleam, and are inflamed; the pulſe becomes quick and hard; and from the exquiſite expectation of relief, ſhe looks wildly round on her attendants, loſing all reaſon and recollection; ſhe is frantic, with the moſt agonizing pain to which the human frame is ſubject. Now the occiput of the child begins to project with its wrinkled ſcalp through the external parts, but nature intends that this alſo ſhould dilate ſlowly; the ligaments and os coccygis reſiſt ſeveral throes, and direct the head forward under the pubes; at laſt after ſeveral pains, it riſes with a half turn, and is delivered.

4th. The fourth ſtage, is the delivery of the body and ſhoulders; and,

5th. The

5th. The fifth ſtage, is the delivery of the placenta. The placenta is expelled by a continuation of the ſame action of the womb, and is part of the natural proceſs. Firſt a flow of the liquor amnii and blood follows the child, and the woman lies for a time exhauſted; the extreme pain and excitement having ceaſed. The womb generally recovers its powers in about twenty minutes, and then there is grinding pain in the belly, and the placenta is detached and expelled, or is puſhed down into the vagina.

Thus we have ſketched, in the moſt ſuperficial manner the progreſs of a natural labour, with a view merely to explain the general notion of the entire function of the womb, not with that minuteneſs which the accoucheur would look for in treating the ſubject. Let us for an inſtant, attend to the ſtate of the umbilical cord, and the final contraction of the womb.

I have already obſerved, that while the membranes are unbroken, the child is ſafe, that is to ſay, there is no danger of the compreſſion of the umbilical cord; but when the membranes have burſt, and the waters are evacuated, the cord muſt ſuffer a degree of compreſſion bewixt the uterus and the child, and there is danger that the cord may fall down before the head, until the head has deſcended into the brim; as the uterus contracts, and as it were follows the child, the circulation through the placenta muſt become ſomewhat difficult, and the uſual function correſponding with that of the adult lungs impaired. This muſt be much more the caſe when the child is delivered, and the placenta remains in the contracted womb. No doubt nature intends by this, that the function of the placenta ſhall be gradually diminiſhed, and not ſuddenly cut off, that the child may feel occaſion for the play of the muſcles of reſpiration, and that the function of the lungs may, by degrees, take place of the function of the placenta. When the child is firſt delivered, the cord pulſates ſtrongly; when the child cries, it becomes feeble; at firſt, the child has ſtrong and irregular catches of the reſpiratory muſcles, but by and

bye

bye it breathes more regularly, and cries luſtily. At firſt the breathing only renders the pulſation of the cord feeble, but preſently the pulſation becomes ſo weak that it is felt only near the umbilicus, and it ceaſes when the regular and interrupted breathing is eſtabliſhed, and the crying ceaſes.

The delivery of the child and placenta is followed by a conſiderable efflux of blood. But after this there continues a diſcharge from the uterus which is called the lochia. It is like the exudation of blood from an extenſive wound, in as much as by the contraction of the veſſels from which it flows, it becomes ſerous in a few days, and ceaſes gradually like a hæmorrhagy.

This open diſcharge from the womb after delivery, is no doubt a proviſion againſt the conſequence which would naturally reſult from the ſudden and perfect obſtruction and the activity of the uterine veſſels conſequent on delivery. By this diſcharge the activity of the veſſels is gradually relieved, and as it is a diſcharge taking place of the active ſtate of the womb, ſo the ſecretion of the milk in the breaſts, and the giving of ſuck, cauſes the diſcharge to ceaſe much ſooner than it would do if the mother were not the nurſe.

OF THE MAMMÆ.

In man and in children of both ſexes, there is no mark of the breaſt, but the little cutaneous papilla, or nipple. Theſe tubercles are, however, ſurrounded by a zone or diſk, of a browniſh red colour, the areola.

At puberty, as we have ſaid, the breaſt of the female becomes protuberant, and thoſe parts which were in miniature, and without action, quickly grow into a firm glandular maſs (ſpeaking anatomically). The ſhape, rotundity and firmneſs of the gland depends much upon the adipoſe membrane ſurrounding and interſecting the glandular body.

The glandular part itſelf is divided into little maſſes, which again conſiſt of ſmall granules. Theſe ſeveral ſub-

subdivisions of the glands are closely surrounded by membranes.

The lactiferous ducts are gathered together from these lesser granules, and unite into 12 or 15 in number of a very considerable size, as they converge towards the root of the nipple. When milk is secreted, the glands are large, a remarkable distention of the ducts also takes place, for they are then become tortuous and varicose, and serve as reservoirs of the milk. Where they pass through the nipple, however, they are again contracted, and open by small pores upon its surface. The nipple is of a spongy and elastic nature, and suffers a distension or erection. When the nipple is contracted, the lactiferous ducts must be compressed, and perhaps coiled together, so that the milk cannot flow, or flows with difficulty; but by the sucking of the child, the nipple is distended, and the ducts elongated, so that the milk flows. There open upon the areola several superficial or cutaneous glands, which pour out a discharge to defend it and the nipple from excoriation.

Of the arteries, veins, or lymphatics of the mammæ, we need not treat here.

We have many occasions to observe the consent and sympathy which exist betwixt the womb and the breasts. On the first period of the menses, the breasts are much distended. In many women at each return of the discharge, a degree of swelling and shooting pain is felt in them, and the enlargement and shooting pain in the breast, with the darker colour of the areola, is marked as the most prominent sign of pregnancy; with the ceasing of menstruation, which is the cessation of the usual excitement and action of the womb, the breasts contract and are absorbed. Any unusual stimulus or irritation in the womb, as polypus, or cancers, or even prolapsus and excoriation, will affect the breasts, causing them to enlarge and become painful.

When the function of the parts cease, they seem to feel the want of the usual excitement to correct action, and are apt to fall into disease; so it is at least with the

womb and mammæ, for at that period of life, when the ſyſtem is no longer able to ſupport and give nouriſhment to a child, and theſe parts ſubſide from their uſual action, they often become ſchirrous or cancerous, and terminate exiſtence by a tedious, painful, and loathſome diſeaſe.

THE END.

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